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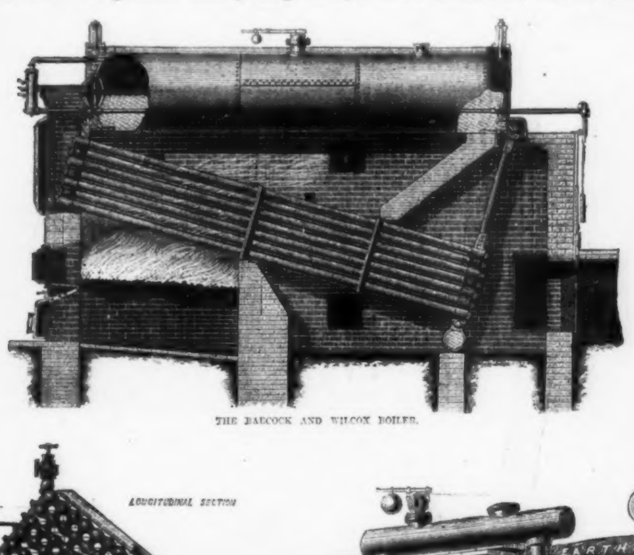
STEAM BOILER EXHIBITS AT THE CENTENNIAL.

In addition to the twenty Corliss boilers and the three Galloway boilers, steam is supplied from a great number of boilers of American make, all of which are varieties of the water-tube type. In spite of the large number of boilers at work, there is a great deficiency in the supply of steam, and great dissatisfaction prevails, especially among the exhibitors in the hydraulic annexe, who can not show their pumps in action between the hours of two and four in the afternoon, when the so-called great cataract is in operation, as there is not sufficient steam to enable the miscellaneous pumps to work when those connected with the cataract are in operation. This is a great hardship for the steam pump manufacturers, as they are naturally anxious to display their productions to the best advantage during the time when the Exhibition is visited by the largest number of people, and their vexation is increased by the fact that the cataract itself makes such a very poor display.

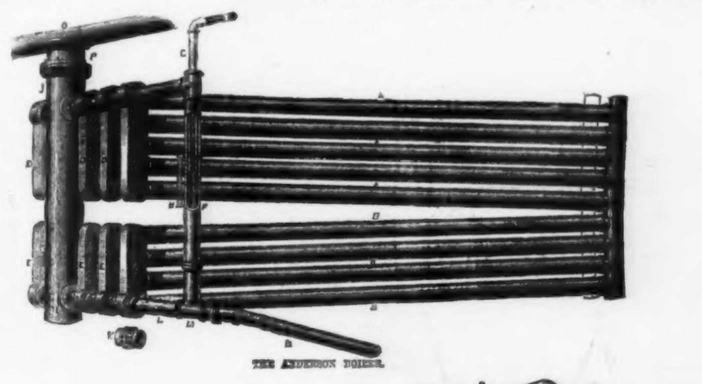
The Harrison safety boiler is formed of a combination of cast-iron hollow spheres, each 8 in. in external diameter, connected with curved necks, with rebated machine-made joints, held together with wrought-iron bolts passing through the spheres. Each single section of the boiler only weighs 80 lbs. The Anderson sectional water tubular boiler consists of two sets of nearly horizontal tubes, the lower set rising from the front to the back of the boiler, and the upper set rising in the opposite direction. These tubes are screwed by right and left-handed threads into flat vertical tubes, the latter being connected together at the top and bottom in the front of the boiler by horizontal pipes at right angles to the other tubes. The tubes are of wrought iron and lap-welded, the vertical "manifolds," as they are called by the maker, being of malleable iron.

Firmenich's wrought-iron tubular boiler consists of two horizontal mud drums A A, two steam and water drums D D, and one steam drum F, the steam and water compartments and the mud drums being connected by a number of heating tubes, C, arranged obliquely, with the grate surface between the mud drums and heating tubes above the mud drums. There is a fire bridge wall, M, dividing the interior of the brickwork into two compartments, and compelling the gases of combustion to take a course from the fire-box upwards over the said bridge wall, and downwards in the rear compartment, escaping through the duct N into the chimney. The mud drums, heating tubes, and the lower half of the steam and water drums D are filled with water, which arrangement enables the division of a large supply of water into small spaces, which better absorb the heat evolved by the combustion of fuel, and results in a large saving of fuel. The lower or mud drums, vary in size from 12 in. to 24 in., and the upper, or steam and water drums, from 20 in. to 36 in., and in length from 4 ft. to 24 ft., according to the capacity of the boiler. The heating tubes are from 2 in. to 5 in., boiler flues from 3 ft. to 16 ft. long, arranged in two or three rows expanded in the mud and water drums. The masonry consists of plain brick walls lined in the inner sides with fire-brick. The mud drums and steam drums are provided with large manholes, which admit of a ready examination of the whole interior of the boiler and easy cleaning and removal of sediment. By holding a light into each heating tube from the inside of the mud drum, and examining them from the steam and water drums D, their condition can at once be ascertained, and by striking them lightly upon the outside any deposit will be readily removed.

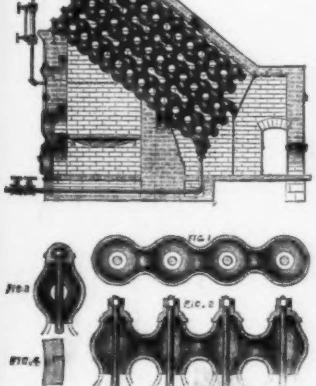
Kelly's sectional steam boiler consists of inclined tubes which have no communication at the rear with any vertical pipe. The tubes are placed at an incline of one in eight, and are screwed into the front chamber, each pipe being perfectly free to expand and contract. The tubes are divided longitudinally by a division plate, which extends nearly to the rear extremity of the tubes, and at the front projects into the vertical chamber, where it curves upwards.



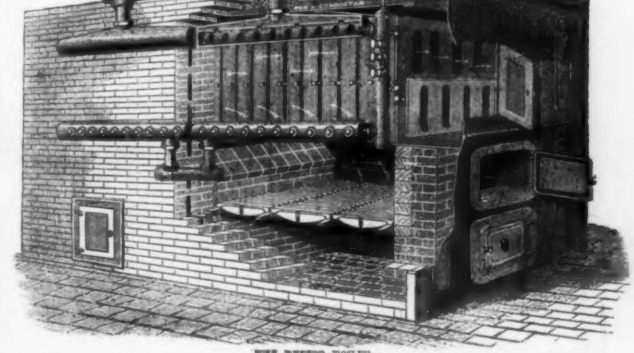
THE BABCOCK AND WILCOX BOILER.



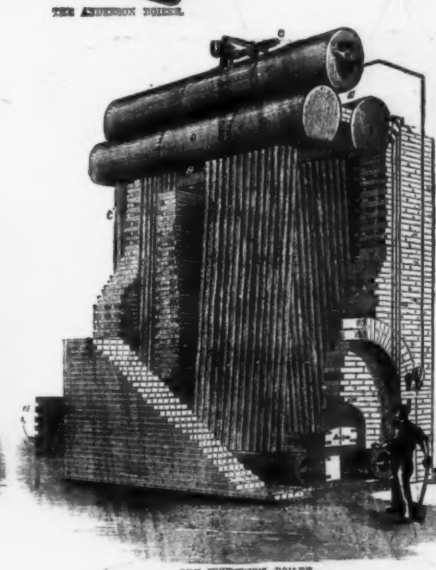
THE ANDERSON BOILER.



THE HARRISON BOILER.



THE EXETER BOILER.



THE FIRMENICH BOILER.

THE INTERNATIONAL EXHIBITION OF 1876.—STEAM BOILER EXHIBITS

The "Exeter" sectional boiler is the invention of Mr. G. B. Brayton, whose ingenious hydrocarbon engine has already been described and illustrated. The cut shows the general appearance of the boiler when set up ready for use. It consists of a series of sections, each of which forms a complete boiler in itself, rectangular in form, 3¼ ft. long, 3 ft. high, and 4 in. wide, the iron being $\frac{5}{16}$ in. thick. Each section is cast with twelve openings through it, 2 in. by 12 in., to give increased strength as well as increased heating surface. There are 29 square feet of heating surface in each section. The brick walls differ from those of the ordinary tubular boiler only by having cast-iron plates to support the sections built into the side walls. The fire-brick lining the fire-chamber can be replaced without disturbing the supports. A cast-iron tie is built into the bridge wall to unite the supports, allow for their expansion, and to prevent spreading of the walls. The sections rest on the supports at sufficient distances apart for the heat to pass freely between them, and to allow for expansion and contraction of the sections independent of each other. The brick walls are 2 in. from the section up half its height, where a heading course is laid to the section. By resting square bars of iron between the sections of these heading courses the draught is completely shut off from upper half, and compelled to traverse between and along the sides of lower half of sections to the rear of boiler; then up and back between openings of upper half of sections to the chimney in front. The connections used to join the sections with outside branch tees are made of extra strong iron pipe, accurately fitted with straight thread for the end screwing into the branch tee and taper thread to enter the section, thus forming a perfectly reliable joint in the section A lock nut fits on the outside next the tee. Any section may be readily disconnected and removed from top of boiler, without disturbing the others or the brickwork.

The Babcock and Wilcox tubulous safety boiler is composed of lap-welded wrought-iron tubes, placed in an inclined position, and connected with each other, and with a horizontal steam and water drum, by vertical passages at each end, while a mud drum connects the tubes at the lower end. The tubes are staggered, or so placed that one row comes over the spaces of the previous row. The end connections are each cast in one piece of steel. The holes are accurately bored, and the tubes fixed therein by an expander. These are connected with the drum, and the mud drum also, by short tubes expanded into bored holes, doing away with all bolts, and leaving a clear passageway to each tube for cleaning. The openings opposite the end of each tube are closed by hand-hole plates, the joints of which are made in the most thorough manner by milling the surfaces, and then accurately grinding them. They are tested and made tight under a hydrostatic pressure of 500 lbs. per square inch, iron to iron, and without rubber packing, putty, or other perishable substances. The fire is made under the front and higher end of the tubes, and the products of the combustion pass up between the tubes into a combustion chamber under the steam and water drum; from hence they pass down between the tubes, then once more up through the spaces between the tubes, and off to the chimney. The steam is taken out at the top of the steam drum near the back end of the boiler. This boiler is provided with more steam space than is usual in generators of this type.—*The Engineer.*

THE SICKELS CUT-OFF.

The original model of the Sickels cut-off is shown in Machinery Hall of the Centennial Exhibition. In the same hall examples of its application are furnished by Russia, England, Belgium, and Canada, and four examples of its application are shown by contributors from different parts of the United States. The patent taken out for this invention has been the subject of protracted litigation. After the patent had expired, a decision was reached in one class of cases that serves to illustrate the importance of exercising great care in the wording of specifications. To make the illustration clear in this case it is, perhaps, best to first state in general terms what the invention really was, as first made by Mr. Sickels.

One portion of the parts forming the valve motion was disconnected from the other so as to permit the steam-valve to rapidly close and cut off the steam. Now, to arrest the rapid motion of the parts disconnected to act as a cut-off, it was necessary to provide some durable means to absorb the momentum; this was done by connecting the cut-off valve with a plunger that acted to expel a fluid through a contracted orifice; the machine was thus rendered capable of great rapidity in closing, without involving destruction to the parts suddenly arrested. The patent was not drawn so as to clearly point out the scope of the invention, as above explained, but was confined to claims for the special application of the invention to poppet-valves, and hence parties using it in connection with slide-valves were held by the decision of the court to not infringe the patent. In a letter written by this judge in explanation of his opinion, he stated that he felt constrained to make the decision as he had done in consequence of the faulty wording of the patent; and if the patent had been drawn properly the users of the invention as connected to slide-valves would have been without defence. Some recent publications have labored to trace a similarity between the cut-off used on the Cornish pumping engine and the Sickels cut-off; verdicts of juries have established the fact that the Sickels cut-off was essentially different from any other cut-off known or used prior to his invention, and while the scope of the patent was limited, the originality and scope of the invention was fully established as here stated. Its extreme rapidity of action, in connection with its durability and ease of adjustment, has tended to extend its use generally. Of the three engines now in operation to drive the machinery of the Fair of the American Institute, two have the Sickels cut-off.

THE INTERNATIONAL EXHIBITION OF 1876.

THE EXHIBIT OF THE STEVENS INSTITUTE OF TECHNOLOGY.

No. 26.

AMONG the many educational exhibits to be found here, both foreign and domestic, there is none which more completely illustrates the enormous advantages enjoyed by the students of to-day over those of the past half or three quarters of a century than that of the above-mentioned institution.

The history of prominent engineering works, utilitarian inventions and discoveries, as well as some of the more purely mathematical and philosophical advances made during that part of the present century now past, reveals the fact that such have been largely due to men who in their early days were without any such opportunity as was even then—and much less as now—presented to the student for acquiring the kind of information necessary to fit him for the particular path or profession he had chosen to follow; and in a large number of cases, men who are now renowned for their great additions to human knowledge, or for some production of vast importance to mankind, were perforce of circumstances (and this particularly applies to engineering pursuits) obliged to commence life as mere apprentices, in possession of the most rudimentary kind of an education, laboring up through the various steps included in the ordinary progress of the artisan until their native energy and genius broke through this circumscribed field, and they began to *educate themselves* for the higher walks of their proposed professions: in this way occupying a great part of their early life in the acquisition of the mere skill of the artisan, accompanied to some extent, of course, where such men are the workers, with the learning of the theoretical principles involved in their work, but always obtained in this way at great cost in time and r every disadvantage.

We may well believe, then, that had these men enjoyed advantages such as for instance are now presented to the student by institutions like the Stevens School, their works would have been still greater and more important, as well as more numerous; and that the next five or six decades will witness advances greater in proportion as the facilities for acquiring knowledge increase.

Recognizing now as a principle that, in order to be able to know how a piece of work should be constructed, it is necessary that one should be competent to construct it himself, the modern schools of technology, such as the Rensselaer Polytechnic Institute, the scientific schools of the Cornell and other universities, and the institution which is the subject of this letter, provide just such means as enable students to acquire the more practical parts of their professions within the schools themselves; and in this way their hands are skilled while their brains are schooled.

Youngest among institutions of this kind is the Stevens Institute of Technology, established and endowed by Edwin A. Stevens—one of those very men who, having been largely without the advantages offered by such schools, the better comprehended the necessity for it.

Though among the youngest of our technical educational institutions, the record of its six years of life, as exemplified in the exhibit made by it in the Main Building, places it in the vanguard of schools of its kind, and reflects the highest honor upon the memory of the man who established it and the professors and teachers who have made for it so rapid an advance.

The exhibit of the Stevens Institute has been selected and arranged with the view of illustrating the following features: 1st. The methods of instruction employed, as illustrated by instruments, models, etc.; 2d. The results of the more practical parts of instruction, as shown in the specimens of works produced by the students; and 3d. The contributions to the progress of science, as shown by apparatus used in original investigations, new substances discovered, or prepared and published papers.

For the illustration of the methods of instruction they exhibit a large number of instruments and apparatus from the various departments of study, a very considerable number of which are the productions of the students themselves in the shops of the Institute. These shops are carried on under the auspices and direction of Messrs. George Wale & Co., and the several instruments, tools, etc., show a perfection of workmanship and finish equal to the best from the older establishments of Europe.

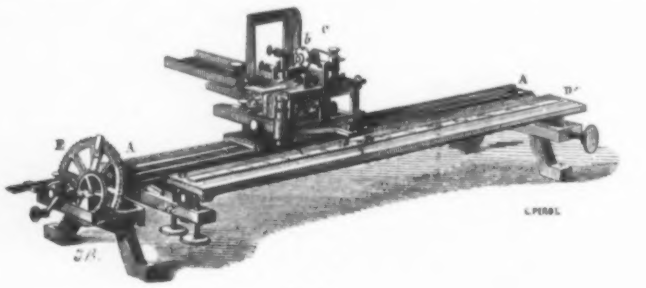


FIG. 1.

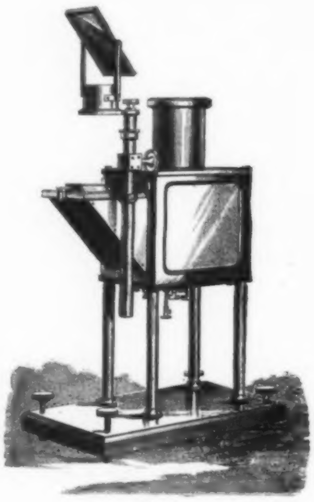


FIG. 3.

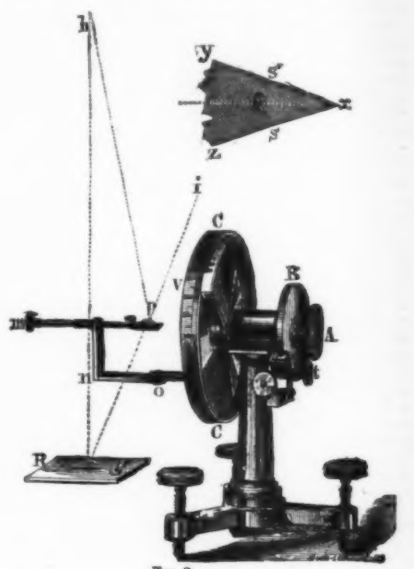


FIG. 2.

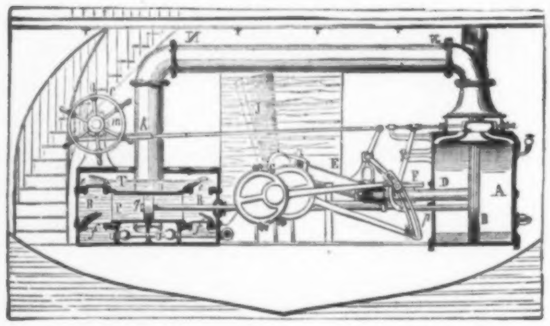


FIG. 4.


FIG. 6.

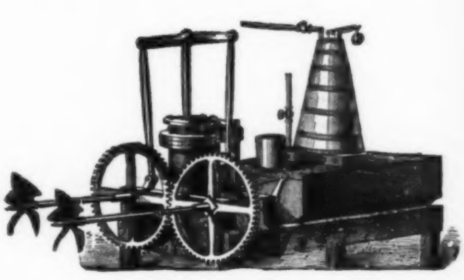


FIG. 9.

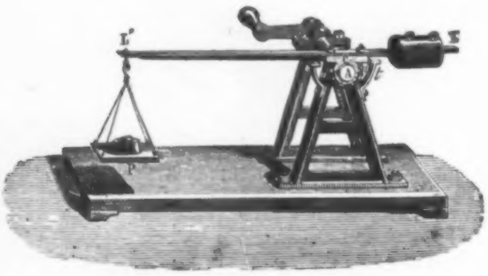


FIG. 7.

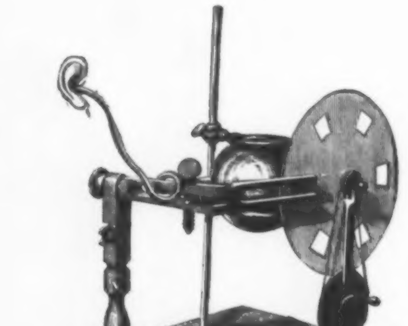


FIG. 8.

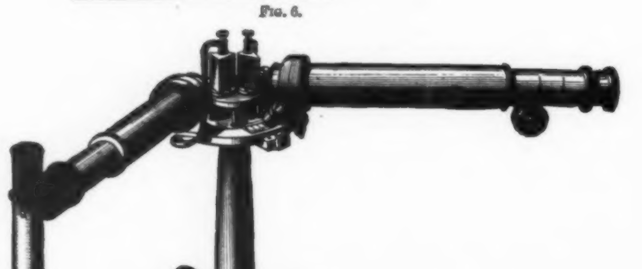


FIG. 10.

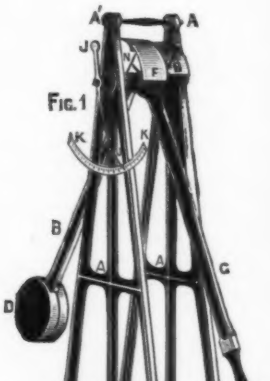


FIG. 5.

THE INTERNATIONAL EXHIBITION OF 1876.—EXHIBIT OF THE STEVENS INSTITUTE.

The work of the student is not only shown here as the production of the mere mechanical expert, but in the designing and proportioning of it as well.

Some of the instruments and apparatus exhibited have, too, a remarkable historical interest, as in the cases of a large Nichol prism, originally made for Sir David Brewster; large selenite devices, unique and extremely delicate; and a number of instruments constructed under the direction of Arago, Fresnel, and others renowned in scientific pursuits, principally in illustration of their optical discoveries.

The collection of materials of construction, and particularly of the useful metals, which at the Institute is an exceptionally extensive and comprehensive one, has not been spared for this exhibit, and is only represented here by a few specimens in illustration of the work of Prof. Thurston's torsional machine.

From the department of physics, presided over by Prof. Alfred M. Mayer, among a number of instruments of precision, such as are placed in the hands of students, and employed by them in the execution of delicate measurements of length, capacity, volume density, weight, time, velocity, heat, light, electricity, etc., etc., is brought an elegant machine, represented in Fig. 1: a linear dividing engine of considerable size and great accuracy, constructed by J. Salleron, and dividing to millimetres; a spherometer with delicate attachment for determining contact; a goniometer (Fig. 2) for the measurement of angles, with large dividing circle; a galvanometer, resistance coils, a rheostat, Dove's polariscope, etc., etc.

In illustration of methods of instruction, there are also shown the large induction coil of the Institute, made by E. S. Ritchie, one of the largest in the world. At the Institute it is accompanied by a very extensive collection of "Geissler," "garland," and "spectrum" tubes, jacketed spirals for fluorescent liquids, and special apparatus which serve with this splendid instrument to illustrate all the characteristics of electric discharge and the phenomena of statical electricity. Then there are shown galvanic batteries, electric light regulators, instruments of projection, such as the vertical lantern of Pres. Morton (shown in Fig. 3), and its numerous attachments for the exhibition of the phenomena attending the polarization of light, etc. Some of the instruments used in the more refined researches on heat, light, and electricity are exhibited; among which are Regnault's apparatus for heat, Tyndall's for radiation, and Thomson's for electricity.

The department of engineering makes an extensive and interesting display, among which are a number of models of elementary constructions in machinery, such as cranks, parallel motions, a turbine step, friction clutch pulleys, and trusses of various patterns and kinds. Considerable of this kind of material is on exhibition in the room of the American Society of Civil Engineers, and among these may be seen a very fine set of car-frame models, tested for the American Master Car-Builders' Association.

From this department are also shown a very fine sectional model of a marine engine, exhibiting fully the interior mechanism of cylinder valve chest, condenser, air-pump, etc. (Fig. 4); also one of Prof. Thurston's autographic testing machines (Fig. 5), and his oil tester (Fig. 6); a Prony dynamometer (Fig. 7); a Woltmann and a Baumgarten mill for measuring the velocity of streams; and one of Worthington's well-known water-meters.

The character of these instruments illustrates very fully the careful and thorough manner in which the head of this department, Prof. Thurston, impresses the lessons of the lecture-room upon the minds of the students.

The department of chemistry and mineralogy, Prof. Albert R. Leeds, presents a number of instruments and apparatus incidental to this branch of study, such as Hoffman's apparatus for the illustration of the volumetric relations of compound gases, blow-pipe apparatus of all kinds, and the large goniometer before mentioned, with numerous attachments. There are also shown many rare chemicals, both organic and inorganic, which have been prepared in the laboratory of the Institute; among which are the rubidio-uranic oxychloride, and the new hydrocarbon, thallene, as well as a number of its derivatives, first discovered and identified by Pres. Morton; also an extended series of anthracene derivatives, together with purpurine, anthra-purpurine, iso-purpurine, alizarine, and related bodies, prepared by Mr. W. E. Geyer. Many of them are the only representatives of these rare substances to be found at the Exhibition.

The part of the exhibit which is of the greatest interest to both teachers and students is probably that which gives the results of the methods of education as represented in the work from the hands of the students themselves. First among these, perhaps, are a number of framed drawings, which include specimens of the principal classes of work done at the Institute under Prof. C. W. MacCord, representative examples of which have been selected. They are none of them mere copies, but have been in all cases constructed, and some from rough sketches. The drawing of the friction governor, by Mr. Poinier; the odontoscope, by Mr. Wallis; the elliptical wheels, by Mr. Ragué; and the Whitworth velocity diagram, by Mr. Reisinberger, are all highly finished working drawings, in which, the conditions having been given, the work was planned, calculated, and executed by the above-named students, exactly as if in active professional duty. The credit, therefore, due for this work is of a much higher grade than that indicated by the mere finish of the drawings. The drawing of a propeller, by Mr. Dow, is also a working plan, and, although most artistically executed, is not a mere picture. It may be added that student Wallis is now constructing the odontoscope from tracings of his drawing, showing that these young men pursue their construction studies through all their phases, from the original design to the finished piece of work.

The shading on several of these drawings is worthy of particular mention. It was first done by Mr. Poinier, as shown on the drawing of Prof. Thurston's governor, and consists in a kind of stippling with the point of the drawing-pen, producing the variations in shade by dots instead of lines or the easy gradations from the brush. It is very effective in producing nice gradations of shadow, and is particularly well adapted to represent the rough surface of the unfinished parts of castings. This student—now deceased—exhibited much originality, and gave promise of a brilliant future as an engineer.

Among the productions of the students are models of two tangent hyperboloids, and also of the epicycloid and hypocycloid as used in toothed gearing, designed and constructed by student Bachmann. Then there are a number of machines and parts of apparatus, designed in whole or in part by the different students, among which is Prof. Thurston's autographic testing machine (Fig. 5), now so well known as designed to test, by torsional stress, the strength, elasticity, ductility, resilience, and homogeneousness of materials. This machine has become widely known through the important discoveries and contributions to science made by the inventor in the course of his investigations of the properties of materials of construction; notably the discovery that iron and steel, after having been subjected to strain in excess of their elastic limit, and caused to remain for a few hours subject to a strain just equal to the equilibriation of their power of resistance, recovered a considerable fraction of their resisting power. Several of these machines have been proportioned in all their details by the class of '76, and built by them in the machine-shops of the mechanical laboratory attached to the Institute. The particular machine on exhibition is known commercially as the "'76 machine." It differs materially from that given in the figure, in the substitution of a worm and gear-wheel for the lever C, by means of which the torsional stress may be applied to the test-piece in a way more easily controlled; and the base of the machine is made heavier to give greater stability to it.

The oil-testing machine (Fig. 6), designed by Prof. Thurston, was worked out in all its details by the students. It is the same as that used in the tests of lubricants made by the Committee on Abrasion and Wear of the United States Board appointed to test iron and steel, of which committee Prof. Thurston is chairman, and by the judges on lubricants submitted for competition at the last exhibition of the American Institute in New York. The details of this machine were designed by student J. A. Henderson, of the class of '73, and made by the class of '77.

A description of this machine may be acceptable to such of your readers as are not familiar with it. In ordinary bearings B, B runs a spindle, upon which is the pulley C, through which motion is imparted to it. This spindle passes through the front bearing, and extends to F. G, G are two half boxes, which may be of any desired material—the machine being capable of testing the frictional quality of the bearings as well as that of the lubricant applied—the lower one of which may be adjusted as to pressure by the screw K, which passes up through the sleeve H for that purpose. N N is a graduated scale with pointer M. The screw K, in moving the pointer M, acts upon a spring inclosed in the sleeve H, and this spring upon the lower half box G; in this way indicating the pressure exerted upon the trial journal F, on the end of the spindle. I is a weight adjustable upon H; Q Q is a thermometer, the bulb of which extends down into a recess in the upper half box G. The parts Q Q, G G, N N, H, I, and K together constitute a pendulum having motion on the centre of F. P P is a graduated arc attached to the frame D, and connected to the pendulum H is a pointer O, marking the angle at which the pendulum may rest. With the spindle F in motion at a given rate, for every modification of the pressure upon the journal, difference in the lubricating qualities of the unguent under test, or deterioration of it under use, the pendulum will occupy a different position on the graduated arc; the thermometer indicates the temperature, and these indications, with the speed of the spindle and duration of test, furnish the data necessary to the determination of the value of the lubricant previously placed upon the journal in accurately measured quantity. The graduations on the scale of pressure and the arc are such that the former divided by the latter expresses the coefficient of friction for the lubricant under the conditions of the test.

There can be no better evidence of the ingenuity of the Professor of Engineering at this institution, and of the care bestowed in the development of that talent among his pupils, than that both of the above machines have received the highest award at each of the exhibitions in which they have been placed, and that they are finding their way into the largest works of the country. The torsion machines have been ordered by and furnished to both our own Government and that of Russia.

Besides these specimens of the workmanship of the student, are: a model of the pitch surface of skew bevel wheels; a model showing form and action of epicycloidal teeth of spur wheels; Morton's vertical attachment for the lantern; Geo. Wale & Co.'s vertical lantern, with polarizing attachments; an automatic regulator for the electric light, for maintaining the carbon points at the proper distance as they become wasted away while in use; a large spectroscope (Fig. 10), involving many improvements; and a large variety of blow-pipe apparatus. All these instruments were made by the students, either as part of their regular work during the course, or, as in the case of the blow-pipe apparatus and others, during vacation and holidays; and they are, without exception, most creditable examples of the proficiency which may be attained in this way, being equal in every respect to the best work to be had from the regular manufacturers of such articles.

In connection with the spectroscope are the various attachments illustrating Pres. Morton's researches and discoveries on the fluorescent and absorption spectra of the uranic salts. In this connection also are shown a series of specimens in illustration of his discoveries and investigations on thallene and its derivatives. There is also accompanying the large induction coil, the rotating disk, apparatus, etc., illustrating Prof. Mayer's researches on the composition and duration of the electric spark; also the apparatus (Fig. 8), the resonator, perforated disk, etc., used in Mayer's experiments on the persistence of auditory impressions.

Among a collection of the more important books and pamphlets containing the published accounts of original investigations made at the Institute since its inception, may be mentioned those of Prof. Thurston, embodying the results of an extended investigation of the physical properties of materials of construction; the changes due to different composition or peculiar methods of treatment in their manufacture, their behavior under stresses variously applied, and the effects of time, temperature, etc.; his paper on the temperature, pressure, and volume of compressed air; those on technical education, and professional reports on matters submitted to him as expert, or as director of the mechanical laboratory of the Institute.

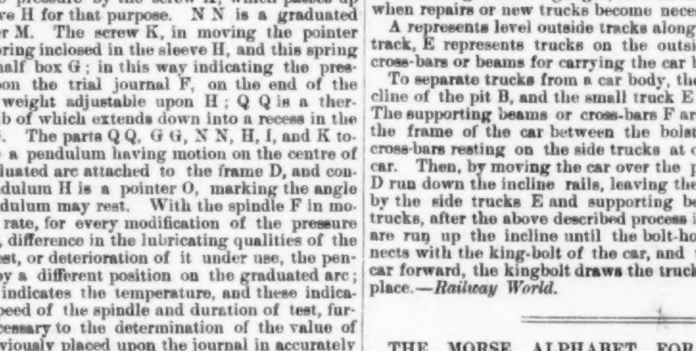
The collection of engineering relics shown here is also very interesting, and of great historical value. In the collection of the American Society of Civil Engineers, exhibited by the Institute, will be found the high-pressure condensing engine, water tubular boiler and screw, which in 1804 drove John Stevenson's first steamboat eight miles an hour on the Hudson; also the twin screw used in 1805 with the same engine. This machine is shown in Fig. 9.

The English patent of 1805 for his boiler and the drawings of his steamboat are also to be seen here, and the latter forms an instructive contrast with the model of the famous Stevens battery, also exhibited in this room.

In the same place may be seen Fulton's own drawing of the engine of the Clermont, the first commercially successful steamboat; also his drawing of the engine of the Chancellor Livingstone. Then there are autograph letters of Fulton and Commodore Decatur, and one from the great English railway engineer, Robert Stephenson.

Another interesting relic is a piece of the first T-rail ever used, designed and laid on the Camden and Amboy Railroad in 1831, by Robert L. Stevens.

We may expect in the future something beyond the ordinary results in the way of technological instruction from an institution which in the brief period of six years has accomplished what is indicated in this most admirable exhibit; and the important additions already made through it to the sum of human knowledge stamp the men in whose hands it has so admirably succeeded as painstaking and earnest workers, and capable in the highest degree. J. T. H.



RAMSEY'S CAR TRUCK SHIFTER AT THE EXHIBITION.

NEW CAR-TRUCK SHIFTING APPARATUS.

By R. H. RAMSEY, of Cobourg, Canada.

THIS device is intended for changing the trucks of cars on roads having different gauges, as well as for changing trucks when repairs or new trucks become necessary.

A represents level outside tracks along the depressed main track, E represents trucks on the outside tracks, and F the cross-bars or beams for carrying the car body.

To separate trucks from a car body, the car is run to the incline of the pit B, and the small truck E placed on each side. The supporting beams or cross-bars F are then placed under the frame of the car between the bolsters, the ends of the cross-bars resting on the side trucks at opposite sides of the car. Then, by moving the car over the pit B, the car-trucks D run down the incline rails, leaving the car body supported by the side trucks E and supporting beams F. To connect trucks, after the above described process is accomplished, they are run up the incline until the bolt-hole of the truck connects with the king-bolt of the car, and then, by moving the car forward, the kingbolt draws the trucks up to their proper place.—*Railway World.*

THE MORSE ALPHABET FOR NAVAL SIGNALLING.

KNOWING the simplicity and effectiveness of this alphabet, Sir William Thomson thought it might well be applied to naval signalling. If report speaks correctly, says *The Engineer*, Sir William has tested his system in a peculiar manner. By a modification of Colomb's method he was enabled to talk with a lady, now Lady Thomson, whilst he was in his cabin and the lady in her residence on shore. Surely the Morse alphabet can not but prove effective. The American Government intend to give the system a fair trial, and our own Admiralty views it with a considerable amount of favor. Prof. Thomson would have every ship fitted up with whistles, or preferably Syrens, giving two different notes. In using one Syren, or whistle, there is some danger in distinguishing the long and short sounds, which is obviated by using two sounds of different pitch. There can be no mistake about these. Suppose, then, we have two different notes, one to represent the dot, and the other to represent the dash, of the Morse system. By combining these sounds, just as combining the dots and dashes, we can make any communication we require. Let the notes used be C and E, then the word "East"

E A S T

would be signalled by the combination C..CE..EEE..E., or seven puffs of the Syren, and the word is transmitted as far as the sound of the Syren reaches. The note C here represents the dot and E the dash. "Full speed ahead" would be signalled thus:

F U L L S P E E D

CCEC..CCE..CECC..CECC......CCC..CEEC..C..C..ECC.....

A H E A D.

CE..CCCC..C..CE..ECC.

COMPRESSED-AIR MOTORS.

TO THE EDITOR OF THE SCIENTIFIC AMERICAN:

IN the description, in your issue of Aug. 5th, of the Mékurski compressed-air motor, I find this, "The most important result of this invention is the possibility of storing the air in carriages at a very high pressure (twenty-five atmospheres or higher), permitting a long journey without recharging the reservoirs."

Experiments I have witnessed in this State, during the past year, have greatly exceeded the above in that direction. A pressure of fifteen hundred pounds per square inch has been maintained for five weeks, without showing any loss whatever by a guage sensitive to very slight changes of pressure, and still higher pressures for several days, or until used out. There is no longer any difficulty in storing air any length of time at this pressure, or passing it through systems of pipes and valves, so long as certain simple conditions are observed. Nor is there any doubt but this means of storing power may be useful in some situations.

New Britain, Conn. F. H. RICHARDS.

NOTES OF STEAM-ENGINES IN THE UNITED STATES ABOUT THE YEAR 1801, AND A DESCRIPTION OF THOSE IN USE AT THE WATER-WORKS OF THE CITY OF PHILADELPHIA.

By FREDERICK GRAFF.

THE first steam-engine of any considerable size appears to have been introduced into America, and put to work about the year 1763, at the Schuyler Copper Mine, situate on the river Passaic, New Jersey. All of its principal parts were imported from England, and Mr. Hornblower (the son, it is believed, of the well-known steam-engineer of that time) came to this country for the purpose of putting up and running the engine.

About the year 1800, the manufacture of the engines for the Philadelphia Water-works was commenced ; and as late as the year 1803, we find five steam-engines only noticed as being in use in this country, as follows :

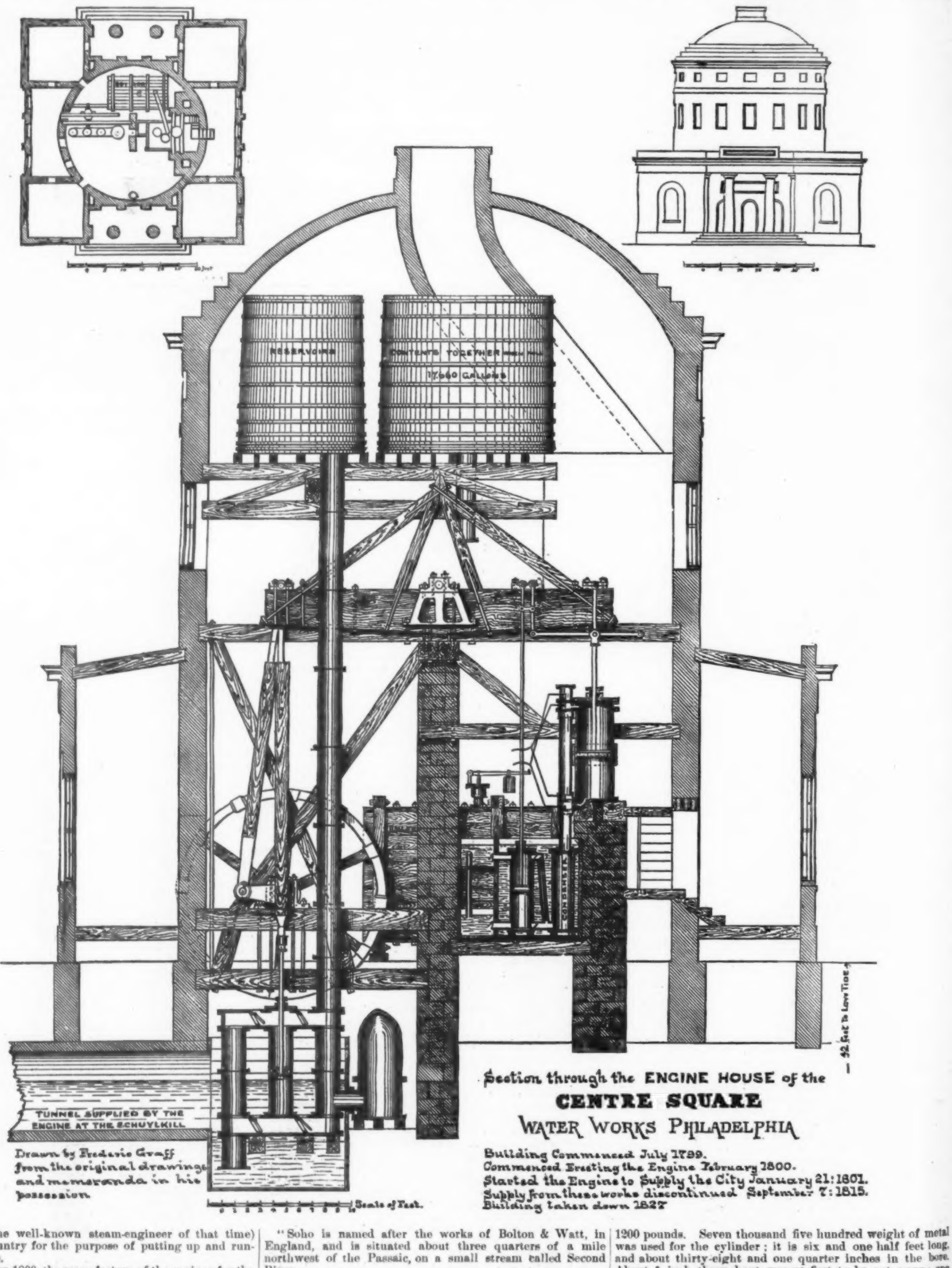
Two at the Philadelphia Water-works ; one just about being started at the Manhattan Water-works, New York ; one in Roosevelt's Saw-mill, New York ; one in Boston ; and a small engine used by Oliver Evans to grind plaster-of-Paris, at the corner of Ninth and Market streets, Philadelphia.

The engines for the Philadelphia Water-works were manufactured by Nicholas Roosevelt, at works established by him near the Schuyler Copper Mine, above referred to.

The following extract from a report made to the Committee on Water-works, by Thomas P. Cope, Esq., who was sent to examine the work upon the engines erecting at the time, will give a good idea of the progress that steam engineering had made to that time, and serve as a measure of the advance made since.

EXTRACT FROM REPORT OF T. P. COPE, DATED JULY 4, 1800.

"Took passage in the stage for Soho Works, near Newark, New Jersey, on the morning of the 3d of July, 1800, and arrived there about noon of the next day.



Section through the ENGINE HOUSE of the
CENTRE SQUARE
WATER WORKS PHILADELPHIA

Building Commenced July 1799.
Commenced Erecting the Engine February 1800.
Started the Engine to Supply the City January 21: 1801.
Supply from these works discontinued September 7: 1815.
Building taken down 1827

"Soho is named after the works of Bolton & Watt, in England, and is situated about three quarters of a mile northwest of the Passaic, on a small stream called Second River.

"The works consist of a smith-shop 90 × 40 feet, with six fires and two air furnaces ; next to this is a room 30 × 20 feet, in which is the fire, for heavy work ; four wooden bellows play into a regulator 15 × 15 feet, with pipes to the forge, and four furnaces for melting and refining copper. Then there is a stone building 20 × 24 feet, two stories high, with six stampers for preparing loam for the furnaces ; next to this is a fitting-shop with large lathe and drilling-machine, and a water-wheel 20 feet in diameter, to bore cannon ; next to this is a shop with a water-wheel 30 feet in diameter for boring large cylinders ; this is now boring a small cylinder for a steamboat, which belongs to Roosevelt, Chancellor Livingston, and others.

"Higher up the stream are the furnaces, 60 × 50 feet, with two air furnaces capable of melting 40 cwt. of metal each, two blast furnaces for melting and refining copper, with a coal house and pattern shop, with two foot-lathes ; all are stone buildings ; the stream affords a head and fall of 16 to 18 feet.

"The large cylinder for the engine to be used on the banks of the Schuylkill at the water-works was cast in two pieces, and united by copper, the joint being secured externally by a strong band of cast-iron, eighteen inches broad, weighing 1200 pounds. Seven thousand five hundred weight of metal was used for the cylinder ; it is six and one half feet long, and about thirty-eight and one quarter inches in the bore. About ¼ inch throughout was at first to be cut away ; one half inch has been accomplished. Two men are required—one almost lives in the cylinder, with a hammer in hand to keep things in order and attend to the steelings (cutters) ; the other attends the frame on which the cylinder rests, which is moved by suitable machinery. These hands are relieved, and the work goes on day and night. One man is also employed to grind the steelings. The work is stopped at dinner time, but this is thought no disadvantage, as to bore constantly the cylinder would become too much heated. The work also stands whilst the steelings are being changed, which required about ten minutes' time, and in ten minutes' more work they

were dull again. I examined some of them and found them worn an eighth of an inch in that time. Three of these steelings (or cutters), about three and one half inches on the edge, are fixed in the head-piece at one time. The head-piece is a little less than the diameter of the cylinder, and six inches thick, secured upon a rod of iron eight inches in diameter, which forms the shaft of a water-wheel.

"The workmen state that the boring was commenced on the ninth of April, and had been going on ever since—three months—and about six weeks more will be required to finish it.

"The wrought-iron for the flue of the boiler over the fire will be imported from England, and is in sheets 38 × 32 inches. That yet made in this country is clumsy stuff of different sizes, the largest being 36×18 inches, with rough edges, which have to be cut smooth by the purchaser.

"Signed, (THOS. P. COPE,)

"July 4, 1800."

The engine for which the above described cylinder was being made was that put up at the water-works on the Schuylkill, at the foot of Chestnut street.

The cylinder was 38½ inches in diameter and six feet stroke, and drove a double-acting pump 17½ inches in diameter and six feet stroke.

The engine at Centre square, built about the same time, and at the same place, had a steam cylinder 32 inches diameter and six feet stroke, and worked a double-acting pump of 18 inches diameter and six feet stroke, raising the water into tanks about 51 feet high.

Chestnut street, on the Schuylkill, whilst lifting the water to the height of thirty-nine feet, and running at a speed of sixteen revolutions per minute, raised 1,474,500 ale gallons of 232 cubic inches each, in twenty-four hours, with a consumption of seventy bushels of Virginia coal. And the engine at Centre square, raising the water fifty-one feet, pumped 962,520 ale gallons in twenty-four hours, with a consumption of fifty-five bushels of the same kind of coal; the pressure of steam, in both cases, being two and one half pounds to the square inch.

As might be expected, great difficulty was experienced in keeping these boilers steam-tight; accordingly, on December 1, 1804, a boiler with cast-iron shell, as well as flues, was put up, and another one, also of cast iron, but of different form, was put in use March 10, 1806. The second of these, which was erected at the works on the Schuylkill, had semicircular ends, was seventeen feet long and eight feet wide at the bottom, and nineteen feet long and ten feet wide near the top; the flame passed under the bottom and around the back into oval flues which passed through the boiler, returned, and passed around the sides outside the shell.

The first had a semicircular top, the ends being flat, and was erected at Centre square. The fire passed under the boiler around heaters of peculiar construction and through one flue of serpentine plan to the front of the boiler; this boiler had two sheets of wrought-iron upon the bottom, just over the fire, all the rest being cast-iron.

These boilers remained in use until the steam works at Fairmount were started September 7, 1815.

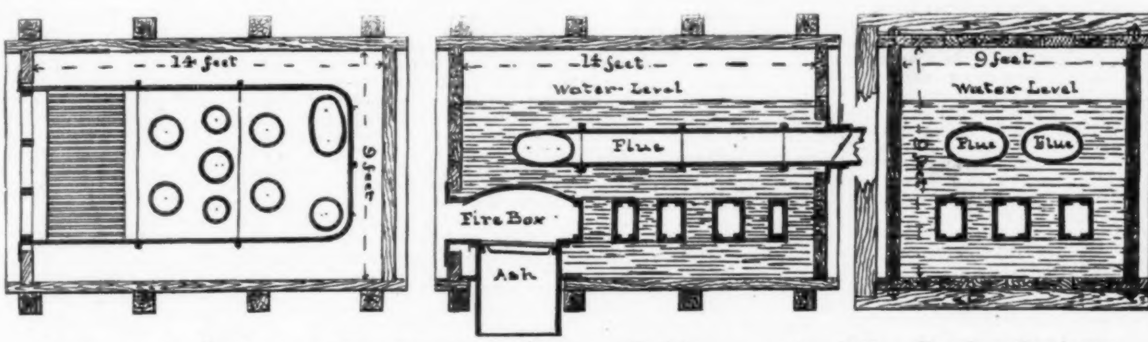
At this last-named works the boiler used was of cast-iron, similar to those at Schuylkill and Centre Square Works, except that the lever beam and fly-wheel arms and shafts were made of cast-iron. They were all on the Bolton & Watt style of that period, with poppet valves worked by hand gear and tappets.

The dimensions of this engine were: steam cylinder, 43¾ inch diameter, and 6 feet stroke; lever beam, cast in two leaves, was 23 feet 9 inches long, between centres; the pump was double acting, 20 inches diameter, and 6 feet stroke; the water was raised 102 feet above low tide; the boiler, as before stated, was cast-iron.

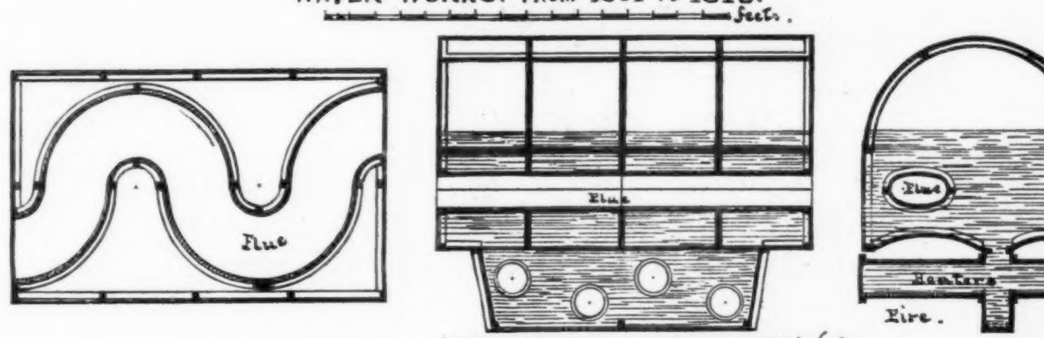
The castings for the engine were made by Samuel Richards, at Weymouth Furnace, and at a foundry then situated within a fourth of a mile of Fairmount. The price paid was for the cylinder castings, $160 per ton; for lever beam, $120; for fly-wheel and shaft, $100, and for the cast-iron boiler plates, $90 per ton; the weight of the latter was 16 tons, 12 cwt. and 39 pounds.

The founder reported that the castings of the cylinder (which had to be cast with the nozzles for the side pipes separate) took all the metal that the "Eagle Works" would hold—namely, 35 cwt.

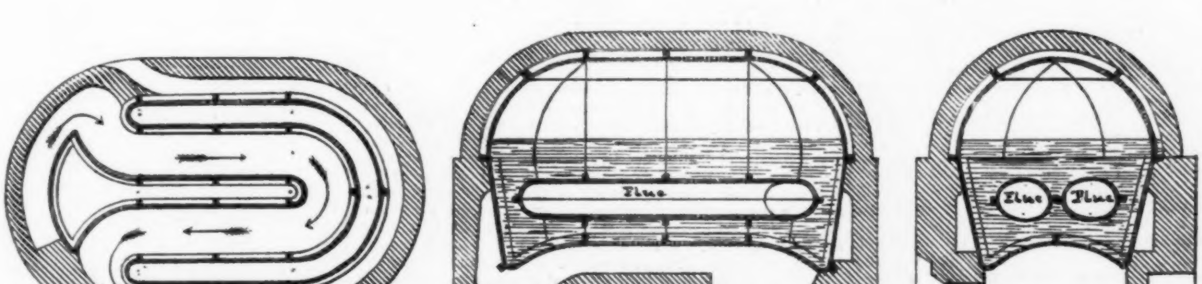
This engine, with steam at 2½ pounds above the atmosphere, raised 2,116,382 United States gallons, with the consumption of seven cords of oak wood; the run was for twenty-four hours, but after the first eight hours it was found difficult to keep the steam up to 2½ pounds pressure, and the engine finally stopped for want of steam; the chimney flue was afterward enlarged, and then steam was carried up to 4 pounds to the square inch; the engine cost $54,341.



Plan and Sections of the Wooden Steam Boiler used at the CENTRE SQUARE WATER WORKS. FROM 1801 TO 1815.



Cast Iron Boiler Centre Square Water Works 1804



In both these engines the lever beams, the arms and shafts of the fly-wheels, the bearings upon which the fly-wheels were supported, the hot wells, the hot and cold water pumps, the cold water cistern, and even the steam boilers were all made of wood. These latter were rectangular chests, made of white pine planks five inches thick; they were nine feet square inside at the ends, and fourteen feet long in the clear, braced upon the sides, top, and bottom with oak scantling ten inches square, the whole securely bolted together by one and a quarter inch rods passing through the planks. Inside of this chest was placed a fire-box twelve feet six inches long, six feet wide, and one foot ten inches deep, with vertical flues, six of fifteen inches diameter and two of twelve inches diameter; through these the water circulated, the fire acting around them and passing up into an oval flue situated just above the fire-box, carried from the back of the boiler to near the front, and returned again to the back, where it entered the chimney. This fire-box and flues appears to have been at first made entirely of cast-iron; then a wrought-iron fire-box was made, the flues still being of cast-iron; this not being satisfactory, on account of the unequal contraction and expansion of the two metals causing leakage, eventually wrought-iron flues were also put in.

Great advantage was at the time supposed to be gained by the non-conducting powers of the wood, and also by the vertical flues in the fire-box.

By experiments made with the engines when the above described wooden boiler was in use, it was recorded that the engine at the plan of boiler being the same as that of the wooden boiler just used at Centre square, except that it had a shell with a semicircular top, made of cast-iron; this was in use from September 7, 1815, to January 14, 1822, when the use of steam at Fairmount was discontinued and water-power works substituted.

The engine at the Schuylkill was started December 22, 1800, and that at Centre square, January 27, 1801. The contract for them both was made March 21, 1779, the cost to be $30,000. The contractor claimed that they cost him $77,-192.

The expense of keeping the engines running in 1809 is reported:

	$6,254.36 for the Schuylkill engine.
and	7,552.87 for the Centre square engine.
	$13,807.23 together.

In October, 1807, a new wooden fly-wheel shaft was put into the Schuylkill engine, and also that at Centre square; the latter engine at the same time had a new wooden lever beam made, the old ones being found rotten. This latter engine had a fly-wheel of 20 feet diameter, substituted for the wheel of 16 feet diameter, first used. Neither of the pumps were originally provided with air chambers; such an appliance was put to the Centre square engine, June, 1810.

The engine and pump first put in at Fairmount, which was started to supply the city, September 7, 1815, was almost

At this works Oliver Evans erected the first large high-pressure engine made by him. It had a steam cylinder, 20 inches diameter and 5 feet stroke, with a rotating steam valve, worked by bevel-gear wheels, driven from the main shaft; it had a double-acting pump, 20 inches diameter and 5 feet stroke; the beam was made of wood, and was suspended at one end upon vibrating standards, the piston rod being attached to the other end of the beam.

The boilers were wrought-iron, 27 feet long, 27 inches diameter, and four in number, upon which steam was at times raised to 220 pounds to the square inch; they were twice burst, three men being killed by the explosion, first time June 20, 1818, and again October 12, 1821.

On the 15th of May, 1817, this engine was submitted to contract test; she ran twenty-three and a half hours; filled the reservoir 9 feet 5 inches deep, being equal to 3,666,021 United States gallons, maintained steam from 194 to 200 pounds to the square inch, and burned 13 cords of oak wood, running at a speed of 22 revolutions per minute.

The use of both these engines was discontinued January 14, 1822; they remained standing in the building until May 10, 1832, when they were sold and soon after removed.

The distributing pipes used with the Centre Square Works, and for several years after the use of steam was abandoned there, were made of spruce pine logs, and varied in diameter from 3 to 6 inches, inside.

Philadelphia was the first works in the country to adopt cast-iron as a material for water-pipe.

The standard sizes adopted at that time (January, 1819), as established by Frederick Graff, Sr., then chief engineer of the water-works, and used with the wooden logs, is in general arrangement precisely like the "globe valves" of the present day, for which numerous patents have been granted.

And also the fire-plugs and stop-cocks designed by Mr. Graff in 1803 and 1822; no fire-plug or stop has been invented since (to my knowledge) that does not contain the general principle, and almost the mechanical form, of these early hydraulic appliances.

The first of the large water mains were cast at the charcoal blast furnaces of Mr. Samuel Richards; one of the very earliest of them is to be seen in the section of the American Society of Civil Engineers, at the Centennial Exhibition, and not only seems to show the advance made in such castings at the time, but also the durability of water-pipes in the soil of Philadelphia, and with the water supplied from the river Schuylkill.

ASTRONOMICAL NOTES.

The Corona Line in the Solar Spectrum.—One of the important results of the solar eclipses of 1870 and 1871 was the discovery that the spectrum of the corona exhibited bright lines, showing that it was composed of glowing hydrogen, and of an unknown gaseous substance, whose presence was indicated by a bright line which corresponded in position with a certain absorption line in the solar spectrum. This dark line in the green is at 1474 of Kirchoff's scale, and sensibly coincident with one of the short lines in the spectrum of iron, but as the more marked lines of iron are not found in the corona it can hardly be inferred that the corona line is due to the vapor of iron, especially as Mr. Lockyer has shown that the short lines—that is, those found only in the immediate neighborhood of the electrode—are due to some compound of the metal, and that it is only the lines which extend to some distance from the electrode that can be considered to belong to the metal itself in a free or uncombined state. In the June number of the *American Journal of Science* Prof. Young has set the question of the identity of the corona line with the line of iron at rest by the discovery that the "1474" line in the solar spectrum is really double, and that the narrower component belongs to the spectrum of iron, while the other is the true corona line. Of course, this discovery is only a small step towards determining the gas to which this latter is due, but at any rate it shows that there is no real connection with the spectrum of iron, and thus clears the ground for future inquiry. Prof. Young has obtained this result by the use of a diffraction grating of lines ruled on a silvered-glass speculum, 8640 to the inch, observing the spectrum of the eighth order. In order to get over the difficulty caused by the overlapping of spectra of the higher orders, Prof. Young has introduced a prism in front of the observing telescope, having its refracting edge perpendicular to the slit, and therefore causing a separation of the colors in a vertical direction. In this way the red of the sixth order falls below the yellow of the seventh, and this underneath the green of the eighth, while above this lies the blue of the ninth, and above that the extreme violet of the tenth.

FRENCH ACADEMY OF SCIENCES.

SEPTEMBER.

On Weather Insurance.—A tornado recently occurred near Orleans, France, destroying some $40,000 worth of property, and doing great damage to crops. M. Faye suggests that weather-insurance companies, guaranteeing losses in such cases, would be useful institutions.

On Vitreous Rocks.—All types of vitreous rocks are related in their elementary composition to groups of crystalline rocks. It would appear at first sight that they might be scoriæ of the latter, and might be reproduced by fusion, or vitrification of the latter. Experiments in this direction have, however, failed to realize such a result, because natural vitreous rocks are hydrated, and often contain volatile matter. On the other hand, it appears that the crystalline rocks may, in many cases, be regarded as the result of devitrification of vitreous rocks; and recent experiments made at the potteries of St. Gobain and Choisy-le-Roi, by Professor Fremy, tend to establish the fact. The vitreous rocks were first melted, in order to eliminate the volatile matter, and then submitted to a high temperature for eight days. Obsidian and retinite thus treated have yielded substances which show that if the treatment were sufficiently prolonged, trachyte and porphyry might thus be artificially produced.

On Examination of the Sea-bottom from Balloons. By M. Moret.—The author and the aeronaut Durnof recently made an ascension at Cherbourg, to the height of 5440 feet, and noted that at that elevation the bottom of the sea was visible, even to the minutest details, although the water was over 250 feet in depth. The submarine rocks and currents were so clearly discernible, that a map of the bottom could readily be plotted. It is suggested that this use of balloons would be of great value in marine surveying, as affording accurate plans of shoals, reefs, etc.

On a New Method of Detecting Artificial Coloration in Wines. By M. Lamattina.—In order to recognize artificial coloring in wine, the simplest process is to mix 3¼ fluid ounces of the wine with half an ounce of peroxide of manganese, coarsely pulverized, and to shake the mixture for ten or fifteen minutes, afterwards filtering through a double filter. If the wine is pure, it passes colorless; if colored artificially, it keeps its color. When pure peroxide of manganese is employed, this process is applicable to all coloring substances artificially introduced, even fuchsin. When, however, the wine after filtration appears yellowish, it is because the oxide employed contains iron. In such case it is necessary to use alcohol, acetic acid, and ammonia in order to determine the presence of fuchsin.

ANILINE BLACK INKS.

LATELY, methylated aniline colors have been prepared of a blue shade, verging so much upon black that they can be applied for the manufacture of black ink. One of these coloring matters is known in the market under the name of *soluble nigrosine;* it dissolves in water almost without residue, and a solution at one eightieth of this substance may serve as ink without any need of adding a thickening. The ink thus obtained is a purple blue-black in the liquid state; on paper it becomes immediately deep black, but its tint does not increase in intensity. It flows well from the pen, does not get mouldy, and when it is dried up its properties may be restored by adding water. It is not quite as black as gall-nut inks, but it presents an agreeable velvet tone. Although prepared with a soluble salt, once dried it is not effaced by washing, and only disappears with great difficulty if we try to remove it whilst still moist, unless it has been too much concentrated. In this case the coloring matter does not penetrate well into the fibres of the paper, and remain slightly adhering to its surface. We obviate immediately this inconvenience by an addition of water. The characters traced with this ink turn blue with acids, but are not destroyed. Thanks to the perfect neutrality of the nigrosine ink, it does not attack pens, and these are only rendered unserviceable by prolonged use. After this ink, which, we believe, is not yet known, follows the induline ink of Messrs. Coupier & Collin, prepared by dissolving induline in 50 parts of water. The inventors contended for the prize offered by the Society of Encouragement, of Paris, for a new indelible ink. Although they did not obtain it, the good qualities of their ink, especially for schools, have got them a gratuity of 500 francs. We have not been able to procure a sample of induline, but we believe that induline ink is identical with that of nigrosine. If the coloring matter of these two inks is not the same, it presents at least the same properties.—*Moniteur Scientifique.*

COPYING INKS.

WITH chromic inks we can not employ gum arabic, because the chromic compounds render it insoluble. The inks of which the coloring principle is soluble are therefore not proper for copying inks. It is otherwise with those that blacken after having been deposited on paper—that is to say, gall-nut inks, the so-called alizarine inks, and logwood inks. All the three have a common characteristic property: the color of the ink at the moment of use is more or less provisional; it is only by the oxidizing agency of the air that there is formed, from the soluble elements of the ink, the final black coloration of the characters. In the case of gall-nut inks, the provisional coloration is produced by a little tannate of iron held in suspension in the liquid, and the ultimate coloration by combination in contact with the air of tannin and the salts of protoxide of iron. With the microscope we recognize in the writing, immediately after dessication, that is to say before oxidation, crystals of sulphate of iron and scales of tannic acid. Once the oxidation is finished the writing can no longer be copied, for it contains then only insoluble tannate of iron. It is pretty nearly the same with alizarine inks; nevertheless with these the provisional coloration is produced by indigo, which always remains soluble in water. This ink will give then, even after complete oxidation, a faint blue copy, but this copy will not blacken afterwards. In logwood inks the provisional coloration is produced either by alum or by chromate of potash; in the first case the ink copies at first red, in the second gray, and the copy only becomes black after the oxidation of the coloring matter. When this oxidation is once finished only the provisional coloration can be transmitted to moist paper, and it is no longer possible to obtain a black copy. From what we have already said, we see that in a copying ink we must above all seek to retard the oxidation of soluble compounds in the ink which, by their reaction in contact with the air, give afterwards a black precipitate. Supposing at first that we avoid as much as possible the influence of the air by the employment of a suitable ink-stand, we succeed in retarding the oxidation by adding to the ink soluble substances, which, in dyeing, envelop it, so to say, in a kind of varnish, impenetrable to the air. Amongst these substances we must mention in the first rank gum senegal and gum-arabic. Dextrine and sugar answer also this purpose, but to a less degree sugar has the inconvenience of always being a little sticky after drying. The employment of treacle is not practical, because it contains much hygroscopic salt, which hinders the writing from completely drying. This is why we ought to reject similar receipts analogous to those patented by Delidon, of Saint Giles (Vendée). For these copying inks Senegal gum is preferable to all other thickeners; it is sufficient to add from 450 to 750 grains of gum to 35 ounces of ink. The gummy varnish which envelops the characters is softened on the contact of moistened paper, but this softening is very slow, which renders the operation of copying long and tedious. We do not know up to what point the gum is altered. To obviate this difficulty of solution, and accelerate the operation, we use with success glycerine. We know that this liquid has the property of never drying. If we add to ink, already mixed with gum, glycerine in a proportion corresponding to 40 to 50 per cent of the quantity of gum employed, the ink dries slower, but is soon dry enough to be no longer sticky. On the contact of a leaf of moistened paper, it softens nevertheless immediately, so that the copy may be made in a very short time. We must take care not to add too much glycerine, because then the writing would not dry and remain sticky. We will remark that the addition of glycerine does not diminish in any way the impermeability of a gummy varnish. In most receipts the proportion of glycerine indicated is too great; it is thus that Boettger takes for his copying inks, otherwise excellent, 6 ounces of glycerine to 35 ounces, which renders the characters sticky, even after drying. If the proportion of glycerine is reduced to one third, this ink is of the best. We shall consider as an absurdity the *dry copying* inks—that is to say, inks to which has been added so much glycerine that they would never dry, and consequently copy without having to be moistened. It is evident that these inks are not only transferred on the copying paper, but still also sully account-books, etc. To these inks belong that of Henny, who prescribes the employment of one part of glycerine to three parts of good ink. The preparation of copying inks is the same as that of common inks, of which we have spoken above; nevertheless, we must employ only 60 to 70 per cent of the quantities of water indicated, because these inks, having to give up part of their coloring matter, it would be found too weak if they did not contain more than common inks. In taking this precaution, we may, by a suitable addition of gum and glycerine, convert into copying ink all inks that blacken on the paper, and principally alizarine and logwood inks.—*Moniteur Scientifique.*

POWDER AND TABLET INKS.

IT is very convenient, in travelling, to have in a dry state the elements necessary to prepare immediately a good ink; we thus avoid accidents which may result from the breakage of an ink-stand. The best ink powder which can be used is nigrosine; this substance is dissolved with the greatest facility in eighty parts of water, and gives immediately perfectly black characters.—*Moniteur Scientifique.*

NEW COLORS.

ROSENSTIEHL oxidizes chrysophanic acid in an alkaline solution, and thus obtains a substance which gives, with aluminous mordants, a very solid garnet-red color. According to analysis the product represents a higher homologue of purpurin, as chrysophanic acid itself is a higher homologue of alizarine.—*Dingler's Journal.*

COPPER IN CAST-IRON.

IT is well known that wrought-iron containing some tenths of per cent of copper is red-short; meanwhile in some of the best irons from Siberia was found from 0.01 to 0.03 per cent of copper. In some specimens of steel I found 0.2 per cent of copper; this steel was not brittle, and had been used with success for manufacturing steel axles. The presence of copper was found in several specimens of cast-iron coming from blast-furnaces of the South Oural mountains. These specimens, when examined and analyzed, showed that the presence of copper in cast-iron may amount to a higher percentage than in steel or iron without altering the quality of the metal. Unfortunately it is not so with wrought-iron or steel. The specimen examined was much used for castings; it filled up the moulds beautifully, and had a very handsome appearance · fresh cut it had a dark gray color. Under the microscope small grains of copper were easily remarked in the mass of the metal. This peculiar sample of cast-iron was carefully analyzed, and the analysis gave the following average composition:

	Per cent.
Iron	83.514
Copper	8.128
Tin	1.252
Cobalt	0.501
Silicium	0.952
Tungsten	0.125
Carbon	3.001
Manganese	2.312
	99.780

While analyzing some iron samples for copper I often used, in case only traces of copper could be detected, the following method: The specimen is dissolved in hydrochloric acid, and the copper and iron are precipitated by an excess of ammonia; the mixture is boiled and filtered; the blue liquor is evaporated nearly to dryness, and the resulting residue is dissolved in sulphuric acid. Into this solution a piece of magnesium ribbon is placed, which, in case of traces of copper, is quickly covered with a layer of this metal; that is easily observed under the microscope.—*Chemical News.*

NEW PROCESS FOR ESTIMATION OF POTASSA.

By M. A. CARNOT.

IN spite of the improvements in the estimation of potassa introduced by Peligot and Schlœsing, its exact determination in a somewhat complex substance remains one of the most delicate operations in analytical chemistry. We have, further, no reagent sensitive enough to detect its presence in small quantities.

The new reaction of the salts of potassa in presence of hyposulphite of soda and a salt of bismuth in a solution mixed with alcohol solves both these difficulties.

We dissolve in a few drops of hydrochloric acid 1 part of the subnitrate of bismuth—say half a grm.—and, on the other hand, about 2 parts (1 grm. to 1½) of crystallized hyposulphite of soda in a few c.c. of water. The second solution is then poured into the first, and concentrated alcohol is added in large excess. This mixture is the reagent.

If brought in contact with a few drops of the solution of a potash-salt it at once gives a yellow precipitate. With an undissolved potassic salt it produces a decidedly yellow coloration, easily recognized.

All potassic salts with mineral acids are equally susceptible of this reaction, sulphates and phosphates as well as nitrates, carbonates, chlorides, etc. It is also very sensitive with the organic salts, tartrates, citrates, etc.

The reaction is not interfered with by the presence of other bases with which nothing analogous is produced. The character is, therefore, perfectly distinct.

Baryta and strontia alone may occasion some difficulty, by reason of the white precipitates of double hyposulphites which they form with the same reagent; but it is very rare to meet them along with potassa, and they are very easily detected and removed.

If we have a solution containing merely a few milligrms. of potassa, it is reduced by evaporation to a very small volume, or even to dryness, when the characteristic reaction readily appears. Or slips of filter paper may be repeatedly saturated with the dilute solution, and after drying be steeped in the alcoholic reagent, when the yellow color will appear, especially on the margins of the paper.

The author's quantitative experiments refer chiefly to nitrates, chlorides, and mixtures of the two salts. With some special precautions the method may probably be applied directly to sulphates, though these are easily converted into chlorides by chloride of barium, removing the excess of baryta with sodic or ammonic carbonate.

The hyposulphite of commerce is sufficiently pure for use; the crystals are dissolved in a small quantity of water at the moment of the experiment.

The chloride of bismuth is prepared by treating the pulverized metal with a few drops of nitric acid, evaporating to dryness, and then heating with a very small quantity of hydrochloric acid. The lead possibly present in the bismuth is got rid of by adding to the cold solution concentrated alcohol, which causes chloride of lead to be deposited. Or subnitrate of bismuth may be dissolved in a few drops of hydrochloric acid.

The liquid in which the potassa is to be determined should not exceed 10 to 15 c.c. in bulk, so that the entire volume of the aqueous solutions may not exceed 20 to 25 c.c. For 1 part of supposed potassa we take 2 parts of bismuth or 2¼ of subnitrate with 7 parts of crystalline hyposulphite.

The solution of the potassic salt is placed in a small flask, the bismuth solution is added, then the hyposulphite, the whole is mixed rapidly, and 200 to 250 c.c. of concentrated alcohol are added. The whole is agitated for a few moments, and left to settle. The yellow precipitate collects at the bottom of the flask, and may be filtered after a quarter of an hour, and carefully washed with alcohol.

The precipitate can not be weighed; it is dissolved upon the filter in excess of water; the bismuth is thrown down as sulphide by sulphydrate of ammonia, washed by decantation, collected on a tared filter, dried at 100°, and weighed. The weight obtained may be corrected by separating from the filter a part of the dried precipitate, and heating it again to 150° to 200° in a small platinum crucible, weighing before and after, and correcting the total weight of the sulphide accordingly. The weight of the potassa is found on multiplying the weight of the sulphide of bismuth found by—

$$\frac{3KO}{Bi_2S_3}=0.549$$

The method has been found accurate in presence of soda, lithia, ammonia, lime, magnesia, alumina, and iron.—*Comptes Rendus.—Chemical News*

GROWING FERNS IN CASES.

The following remarks on this subject are abstracted from the *Journal of Horticulture*. They are from the pen of Mr. Halliday:—

The case may be made of tin, earthenware, or wood; it matters not which, so long as proper regard is had to drainage. This, as in Wardian cases, is of vital importance to the healthful growth of plants under the fern shade. I say this is of the first importance, as many persons who have the management of ferneries use so little judgment in their care, that without a proper outlet for water the cases soon become perfectly sodden. I have seen more plants destroyed in cases from want of drainage and from overwatering than from any other cause. Most of the failures I have met with have arisen from either too much water or too little light, and frequently both combined, although the persons having them in charge have strenuously denied that any more water had been used than the plants required, and have insisted that they were placed in a very light situation. The light situation is usually a dark one—generally a space between two windows, with a dead wall behind it, or in a corner receiving a little light obliquely from a window 2 ft. or 3 ft. distant. When the plants are turned out it is found that they have been treated as aquatics, and kept fairly up to their knees in mud and water. Then people wonder at their want of success.

The hanging fernery was my first attempt in this direction. I designed it to take the place of the hanging basket, which so seldom appears in good condition in the home. The case was turned from walnut, several pieces being glued and nailed together to get the proper depth, and also to keep the wood from warping. It tapered to a point at the bottom, to give lightness to its appearance. A zinc pan with a rim to receive the shade, fitted the case loosely enough to be readily removed when watering was necessary. This case as first constructed was covered with a shade 8 in. in diameter and 10 in. high, and was suspended by silvered copper wire. The case first exhibited in this hall in June, 1871, had a shade 12 in. in diameter and 14 in. high; was elaborately turned from maple and walnut, ornamented with ebony trimmings, and filled with the following named plants:—Onychium japonicum, Adiantum assimile, A. cuneatum, Selaginella Wildenovii, Panicum variegatum, Fittonia Pearcei, F. argyroneura, Lycopodium denticulatum var., and Mitchella repens, some lichens and wood mosses.

This case when taken from the hall was suspended in my window, where it received the morning sun for about an hour each day, and was not disturbed again till January, excepting when it was occasionally turned to the light. It was then a mass of green. I noticed considerable soil on the glass, carried up by slugs in their nocturnal rambles; also some decayed fronds of the Adiantum. Altogether it was as much of a success as a close case could be, and would probably satisfy most people who grow plants for home decoration.

There are some plants that seem better suited to a close case than to any other situation. They are confined chiefly to the Lycopods and Selaginellas. Many of them are very beautiful, rivalling, and in some cases closely resembling, their allies the ferns in beauty of form and delicate feathery appearance. The Fittonias are another class of plants which are favorites with me. Their bright crimson and silver veinings are a great acquisition to the fernery, lighting it up wonderfully, and seemingly never out of place, no matter what the size of the case may be. They also make superb plants by themselves.

A few weeks since I had the good fortune to be shown a plant of Todea superba growing in a Wardian case. The case was about 2 ft. square, and as many feet high, with a flat top. A pan about 8 in. in diameter, filled with this truly superb plant in vigorous growth, occupied the centre. Other filmy ferns are planted out in the case; but this, the grand object of the whole, was elevated several inches above the others, showing conspicuously its full beauty. I have seen larger plants of this species, but none in such fine condition. It was grown in a cool room near the west window, the light partly obscured by a drawn shade. This plant is just the thing for a large fern shade, as it needs as little air as the Selaginellas, very little light, and a cool situation, and when once established needs but little attention. The filmy ferns are eminently fitted for growing singly in cases by themselves. The only objection is the expense of many of them, but I would rather have one plant of Todea superba than dozens of ordinary ferns.

The great difficulty I have always found in ferneries is to reach the plants after they have filled or partly filled the case. It is easy enough to remove the shade, but to replace it so that the plants may retain their former positions is not so easy. This is so with regard to delicate ferns; the fronds will tip about, look out of place, and otherwise mar the arrangement. If you could only reach them from the top all would be remedied very quickly. Frequently I have been forced to allow a large slug to have his own way rather than disturb the shade when the case was looking well, and in many instances have allowed decayed fronds to remain rather than run the risk of destroying the arrangement by removing the shade. It was almost as much on this account as for ventilation that I constructed the dome top or ventilated fern case, which is as easily managed as an ordinary Wardian case. Lifting the dome does not disarrange the plants, as they are all confined within the cylinder, which need never be disturbed for this purpose. This case is constructed as follows:—

The case or stand is of wood, 6 in. deep, and resting upon three small feet. There is a large opening underneath, covered with a movable slide to admit or exclude the air. It has a zinc pan ½ in. less all round than the wooden case. This ½ in. space is covered all round at the top of the pan, which leaves a flat surface of zinc 1 in. wide, with an outside rim to receive the glass cylinder. This flat surface of zinc is pierced with ¼ in. holes in its entire circumference about 3 in. apart. When the glass cylinder is in place the ¼ in. holes are inside the case. The cylinder, of annealed glass, fits neatly into the zinc rim, and is 15 in. in diameter by 14 in. in height. Encircling the upper edge of the cylinder is a copper rim 1 in. wide, with edge turned downwards on the outside ½ in. wide to fit on to the cylinder. The flat surface of the rim is perforated with 1 in. holes, and the inner edge turns up ½ in. to receive the dome or cover, which is 8 in. high and 12½ in. in diameter. The holes in this copper rim are on the outside, so that when the valve in the bottom of the case is open the air passes up through the holes round the zinc pan and out at the copper rim. The whole case when complete stands 29 in. high from the table.

There are very few foliage plants that can be introduced into the fernery. I would recommend only plants of dwarf habit, such as Panicum variegatum, a very pretty grass, with pink, white, and green foliage; and a small variety of Bambusa. Cyperus alternifolius var. is quite pretty when a small plant, but the growth is almost too rapid for a fern case of an ordinary size. The foliage is light and graceful, and contrasts prettily with ferns. It is a charming plant for the Wardian case.

Rockwork in a case of the size just described has a very pretty effect when well arranged. This is a difficult matter to accomplish, and I generally prefer the case filled with plants rather than rocks, though for variety I occasionally introduce them. I use coke and pumice stone soaked in water, and sprinkled with cement to give color. These substances are very light, and answer the purpose well. Quite small plants only are fit to be used with the rocks.

I have had this ventilated case filled with the following-named plants, and the effect was highly satisfactory:—Nephrolepis exaltata, Adiantum colpodes, Onychium japonicum, Selaginella umbrosa, S. Wildenovii, Panicum variegatum, Lycopodium denticulatum var.; near the glass Fittonia Pearcei, F. argyroneura and Peperomia maculosa, and suspended in the shell a plant of Selaginella cœsium. This last is the prettiest basket plant I have ever used for summer decoration.

Management.—In the selection of a fern case I should choose one with an outlet for drainage. This I have already said is very essential, especially for a novice. If there is no drainage, water must be used very sparingly. Crocks and small pieces of charcoal, covered lightly with old moss to keep the soil from sifting down through, are the best for drainage. I prefer a case constructed of wood. For a case that will require a shade 12 or 15 in. in diameter, take 3 pieces of plank—walnut or other hard wood—2 in. thick, fasten them securely together with glue and screws, forming a solid piece of wood 6 in. thick. The inside of this piece of solid wood is to be removed by the saw, leaving only a rim to support the zinc pan, which is to contain the soil. This wooden rim, which is to be turned in finishing, can be ornamented if you wish. The case when complete will last for years. The heat and dampness will not affect it, provided no water is thrown over it. A zinc pan, with an opening in the bottom for drainage, fits into the wooden case. The pan is made with a rim to receive the shade; this will prevent water from coming in contact with the wood. This wooden case will cost about double the price of one made of earthen or lava ware; but it presents a better appearance in the room, and there is no trouble from scaling-off or cracking, as is often the case with earthenware. Very few of the latter are properly constructed for drainage, therefore I would recommend a wooden case. The larger the case the more satisfactory it will be. Frequently in selecting a case one has to be guided by the space he can afford for it; but I should say the larger the case the better. I have had cases no larger than 4 in. in diameter, but, of course, they were mere toys, though better than none if you have space for one no longer.

If you have a wooden case designed for a shade 15 in. in diameter make it 6 in. deep. This will give you 2 in. of drainage and 4 in. of soil, in which can be grown any plants suitable for a case of this size. Most of the earthen fern cases are not more than 4 in. deep; this depth will answer for those of small size, but it is not sufficient for larger cases. The soil and method of planting recommended for Wardian cases are suitable for ferneries, also the same general treatment will answer for a ventilated fern case.

A fern case for winter decoration ought to be filled in August, or not later than the 1st of September. This will give the plants time to get fairly established and make new growth for the winter before the short cold days commence. Cases filled later in the autumn afford very little satisfaction or pleasure, as they rarely get under way or begin to make new growth until spring, if they do not wholly die out during the winter. Were I intending to fill a case for my own use I should certainly plant early.

For the close case I should only use such plants as are suitable. Disturb the shade only when water is required, or signs of mould are visible, or the plants damp off; then give air for a short time each day, wiping out the glass when it is removed. This will generally remedy the trouble when practised a few times. When the plants are in vigorous growth and during the warm weather give considerable water, but withhold it almost entirely during the winter, and give plenty of light at all times.

GRAPE MANAGEMENT AND PRUNING.

The *Massachusetts Ploughman* gives the following account of the plan pursued by a Mr. Blanchard in the cultivation of Concord grapes:

On a favorable soil, but in an exposed locality, he has ripened, year after year, on each of his well-grown vines, from twenty to twenty-five pounds of grapes, in clusters weighing from sixteen to thirty ounces each. He grows no small clusters, and using only ground bone, ashes and plaster of Paris as fertilizers, spread broadcast on his land, his vines continue perfectly healthy. His success depends upon no local advantages which may not be found in almost every garden or farm. His method is as simple as it is successful. His ground was prepared as if for corn. In rows eight feet apart, running north and south, good layers are set eight feet apart. The roots are carefully covered about four inches deep; the surface of the ground kept level and free from weeds by a light cultivator or otherwise. The work of the first two years is to grow good strong healthy roots. To this end, a single cane is grown and tied to a stake, pinching off the end if it grows too tall and slim. After the leaves fall, cut this to the ground, leaving only one or two buds, from the better of which to grow a similar one the second year. This is to be treated in the same manner, except that in the fall it is to be cut eighteen inches from the ground.

The third year, a trellis running north and south should be erected, the lower rail or wire twenty inches from the ground, with two above, nine inches apart. No. 15 galvanized wire is the best for this. From the two upper buds on the cane, grow two shoots in opposite directions on the lower wire, pinching off the ends when they have grown four feet. These are to be permanent arms, never allowed to grow longer; but on these arms allow laterals to grow ten or twelve inches apart; tying them to the upper wires, but pinching them back occasionally to make them grow stout. They should not grow much above the upper wire. If shoots should come out of these, they should be pinched off in the same way. At the end of the season there will be two strong arms, each four-feet long, with eight or ten laterals bearing good strong fruit buds. After the leaves fall, prune the laterals, leaving only two buds on each, with the auxiliary or arm bud at the junction.

In the spring when the buds start, save the arm bud and the better one, on each lateral, rubbing off the other. Let the arm bud bear only one cluster of grapes, the other two. When these shoots have made three leaves beyond the blossoms, pinch off the last leaf and the blossoms, except the three clusters above named, always saving the best clusters. They should now be tied to the second wire. When three more leaves are pushed out, pinch off two of them; do the same if shoots come out of these.

This is to be continued through the season, allowing the laterals to grow to the upper wire. Pinch out every thing else that starts from the vine. In the fall there will be two laterals and three good clusters of grapes at each joint of the arms. The vines should always be kept in this shape, with no longer arms, no more laterals and no more clusters of grapes. It is all the roots will bear and continue healthy. In order to keep the vine in this shape, prune in the following manner: Cut the lateral which grew from the upper bud and bears the two clusters, back close to the arm, and prune and treat the other one just as the year before. By letting the lateral which grows from the arm bud bear but one cluster, it will give stronger buds for fruiting the next year. This method of pruning directs the whole root power to the production of fruit and fruit buds, and avoids the unsightly spurs which deform a vine; equalizes the labor of the vine, producing uniform results, never overtaxing it one year at the expense of the next.

TEMPERATURE IN RELATION TO THE GROWTH OF PLANTS.

Signor Cantoni, the director of the Agricultural Institute of Milan, has long been engaged upon a series of meteorological observations, more particularly with the object of ascertaining the influences of the differences in temperature of the soil and air on vegetation. An abstract of the results obtained is given in a recent number of the *Annales Agronomiques*. The commencement of growth in spring, its continuation and arrest, depend upon physico-chemical causes connected with the temperature of the soil and of the air considered both abstractly and in relation to each other. But growth of the herbaceous portions of a plant, at least according to Cantoni's conclusions, is actually favored by a soil whose temperature is several degrees below that of the air. Growth takes place, he asserts, when the difference in the temperature of the soil and air equals or exceeds 3° Cent. A smaller difference is required for the formation of starchy, and particularly of sugary, matters. Signor Cantoni thinks that by careful observations of this character we may hope to understand why plants in the same climate, in the same soil, and subjected to the same general conditions, do not begin and cease to grow simultaneously; why one plant absorbs more carbonic acid than another; why the same plant sometimes absorbs more, sometimes less of the gas, and why, when absorbing the same quantity of the gas, it varies in vigor; why growth ceases in autumn though the air is notably warmer than in spring, when growth commences; and a number of other problems of plant-life.

CARROTS FOR HORSES AND CATTLE.

No food of the root kind is so keenly relished by horses as carrots; indeed, most horses prefer them to oats. Carrots, when mixed with chaff, without corn, will keep horses in excellent condition for performing all kinds of labor. They may be fed from December to the beginning or middle of May, to which period, with proper care in this latitude, they may be preserved. They are especially beneficial for horses toward spring, at which time corn may be added for a few weeks. In certain parts of Europe farmers depend solely upon carrots, with a proper allowance of hay, as winter food for their horses, without giving them any grain whatever; and it is asserted that by this mode of feeding farm horses a considerable saving of hay is effected, as compared with the usual custom of the country of feeding corn and hay. Draft and farm horses are given in the proportion of fifty to seventy pounds weight of carrots each per day on an average, not allowing them quite so many in the very short days, and sometimes more than that quantity in the spring months. A portion of the carrots are sliced in the cut chaff or hay, the rest are given whole to the horses at night, with a moderate quantity of hay, in their racks; and with this food the horses will usually enjoy uninterrupted health. There are persons who think that carrots only given as food to horses are injurious to their constitutions; but this belief is without foundation other than prejudice. Experiments carefully conducted have proved that team horses, winter and summer, will perform ordinary work on carrots as a winter food, with the assistance of proper soiling in summer, and may be kept the entire year round upon the produce of an acre of land in carrots.

Without reference to the many local opportunities of a market for the sale of the carrot, it is the most valuable esculent in the entire range of practical husbandry on account of its superior properties as a general article of food for several descriptions of animals usually kept on a farm. The only reasonable objection urged against the more general introduction of carrots into the regular system of cropping is their expensive and tedious early culture, which objection certainly has considerable weight. Nevertheless, when capital and industry can be combined, carrots offer a fairer opportunity of a remunerative return than any other comparative crop, and where introduced will be found a valuable article of food for horses, pigs, and poultry of all descriptions. Butter of the most agreeable appearance and exquisite flavor may be obtained for the table by feeding milch cows upon carrots, and if stored for them during severe weather in winter there will be no diminution in quantity, or deterioration in the quality of their produce.

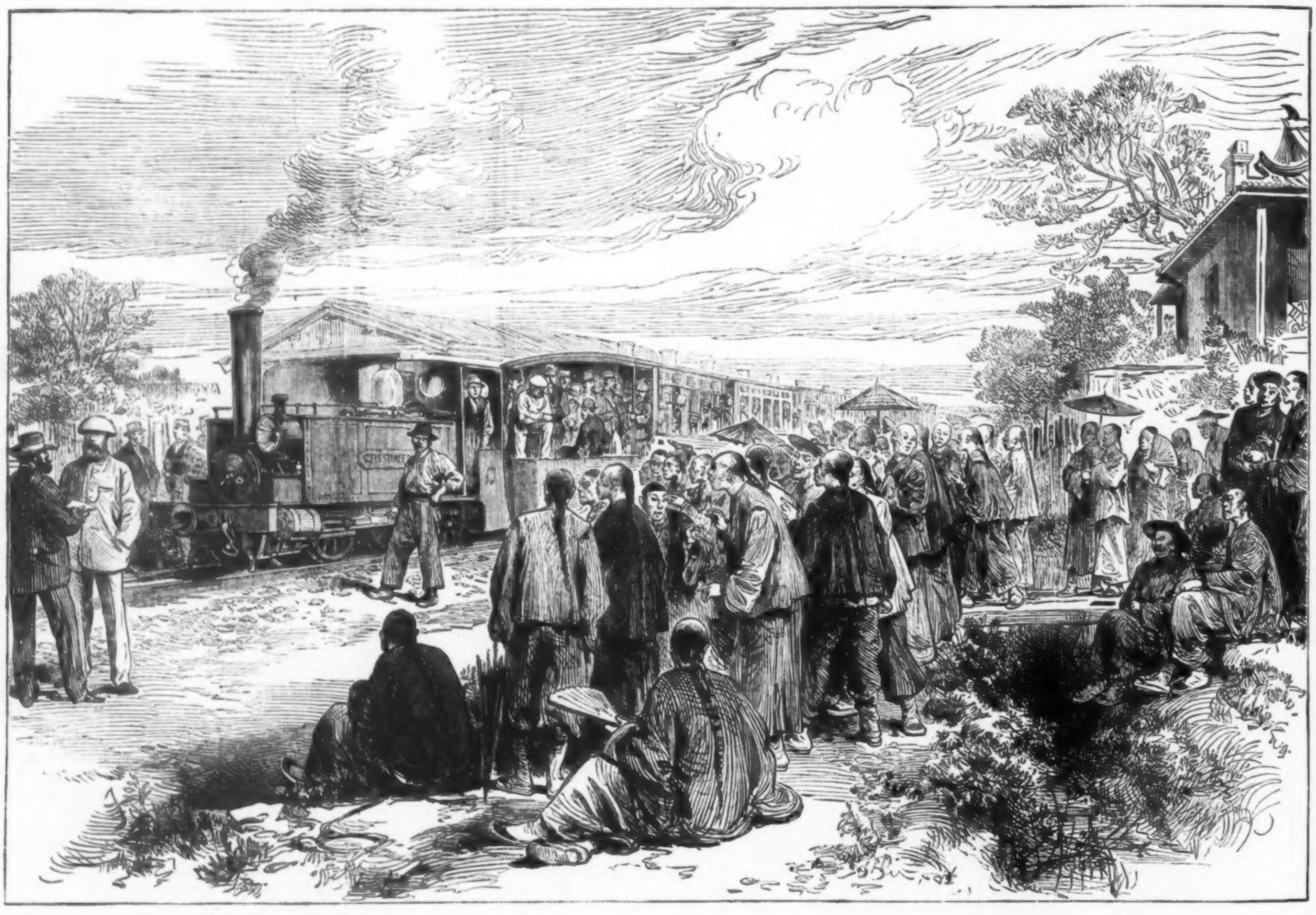
In establishments for trotting or racing horses, carrots are especially beneficial. Toward spring, when the horses have been fed many months on dry food—oats, corn, and hay—they are extremely serviceable, indeed necessary. Among horsemen they have gained the character of being good for the wind; but we suspect the only merit they can claim in this respect is that they keep the body cool and properly open, by which they conduce greatly to health and condition, and consequently to clearness of wind. About the same thing may be said of their claims to producing a fine coat; whatever conduces to health does so; consequently carrots do. To any one who has been in a racing stable, or in any stable where carrots are fed, it may seem almost useless to say that they should be sliced in pretty long slices. It is dangerous to give them cut crossways, as horses are extremely fond of them, and, if at all greedy, would be apt to bolt pieces of them whole, which would be quite likely to cause some of them to stick in the throat. Carrots, if kept in a dry place, in sand, will keep a long time; or, in sand, they will keep out of doors, if covered sufficiently with straw and then banked up with earth.—*National Live-Stock Journal.*

FIRST RAILWAY IN CHINA.

THE opening of the short line of rails from Shanghai to the village of Kangwang, on June 30th, 1876, was an event which marks, we hope, the commencement of a new era in the history of Chinese civilization—that of the introduction of European scientific and mechanical agencies of improvement. This line is rather more than ten miles in length, and the portion now opened, from Woosung to Kungwang, is five miles and a quarter. The line being merely an experimental one, constructed with a view to something better following, is only 2 ft. 6 in. gauge. All the earthwork is finished, and the station houses at Woosung creek and at the signal station at Woosung are built. Seven miles of rails are laid, and of thirteen bridges twelve have been completed, while the thirteenth is in progress. The permanent station at Shanghai is in course of erection, and will be of an ornamental character. The weight of the engines is nine tons, in working order, and each engine carries enough coal and water to run to Woosung and back. The carriages are well built and fitted; they are 5 ft. wide, and constructed to accommodate twenty passengers in the first-class, and twenty-four in the second and third. The principal part of the earthwork had been executed before a contract was entered into with Mr. Dixon, of London, for the completion of the line and the supply of all the necessary materials and rolling stock. This portion of the work has been executed under the direction of Mr. Morrison, the company's engineer. It was not expected that the line could be opened to Woosung in time to be of much service during the hot weather of this summer. Some delay arose from the whole enterprise being on such a small scale. A sufficient amount of plant, and the experienced staff requisite to carry out the railway work quickly and efficiently, would have cost as much as the whole line. In the case of any large works being carried out they would be executed much more rapidly.

On the opening day invitations had been sent to as many ladies and gentlemen of the European settlements as the six carriages, which at present constitute the total passenger rolling stock of the company, would comfortably accommodate. That number was 164, and we believe all accepted the invitation. Half-past five was the time appointed for the start from the goods platform, at some distance down the line from where the Shanghai station is in course of erection. Almost to the minute, the guests having taken their places, Mr. Morrison, the engineer and traffic manager, gave the word to go; and the first locomotive in China (appropriately named the "Celestial Empire"), drawing a regular passenger train, gave its premonitory shriek and whistle, and glided out of the station, amid the cheers of those assembled on the platform. The open country was soon reached, and the train went steadily along at about fifteen miles per hour, with a remarkable absence of oscillation. The country people at work in the fields only ceased from their labor for the little time occupied by the train in passing by, and then quietly resumed their employment. They seemed immensely interested, but decidedly in the sense of enjoyment rather than hostility. Several bridges and crossings were passed, at each of which there was a group of lookers-on; but these probably had been so accustomed to the daily passing to and fro of the little engine "Pioneer," with the ballast wagons, that the sight of the larger engine, with the passenger-carriages, was no great novelty. Kungwang was reached in seventeen minutes, and the company, alighting here, found a suitable little station, with passengers' waiting-room and offices, a siding being also provided to allow the passing of the up and down trains. In the waiting-room, which is open on the side fronting the line, was provided an ample supply of champagne and cake. The popping of corks was soon heard, and bumpers were drunk between friends of many different nationalities to the success of the first railway in China. Half an hour having been pleasantly spent in this way, the engine was once more attached to the train; the passengers resumed their seats, and the homeward journey began. Fifteen minutes were occupied in the run up to Shanghai, where the passenger separated, greatly pleased with the success of the little excursion.—*Illustrated London News.*

Drawings of the locomotives above mentioned were given in SCIENTIFIC AMERICAN SUPPLEMENT No. 37.



OPENING OF THE FIRST RAILWAY IN CHINA.—THE START FROM SHANGHAI.

LOCOMOTIVE TESTS, BOSTON AND ALBANY R.R.

THE recent trials of locomotive engines upon the Boston and Albany R.R. has excited considerable attention among railroad men, and questions have been put by them as to the peculiarities and condition of the competing engines. And we here give, as near as we can, the relative forms and proportions of the parts that are thought to bear upon the general result. One of them, the "Brown," is an ordinary mogul engine, having three pairs of driving wheels, and a single pair of guiding wheels, was built by the Rhode Island Locomotive Works, from specifications furnished by the B. and A. R.R. Co., and is about three years old.

The other two engines, the "Virginia" and "Adirondack," were of the ordinary eight-wheel kind, having two pairs of driving wheels, and a four-wheeled truck, were built at the shop of the B. and A. R.R. Co., at Springfield, by Mr. Wilson Eddy, M.M., and have peculiarities long since adopted and adhered to by him. The "Virginia" was new, and the "Adirondack" about three years old. All the engines were put in complete order by parties most interested in them, and also run by men disposed to do them justice. The cylinders of all were the same size, 18 x 26; the driving wheels were also the same diameter, 4 ft. 6 in., except those of the "Virginia," which were 5 ft. The boilers differed in these particulars: the furnace of the "Brown" was 65$\frac{3}{4}$ in. long, 35 in. wide, and 56$\frac{1}{2}$ in. deep; tubes, 162, 2 in. diameter, and 11 ft. 10 in. long. So it will be seen that as to area of grate there were 60 square in. difference in favor of the "Brown," and 42 square ft. of flues in favor of the "Virginia" and "Adirondack." The weight of the "Brown" is 73,600 lbs., 55,200 lbs. upon the driving wheels. The "Virginia" and "Adirondack" 67,150 lbs., and 43,000 lbs. upon the drivers.

The marked differences are in these particulars: The "Brown" has the ordinary form boiler, with steam dome and dry pipe. The "Adirondack" and "Virginia" have straight top boilers, without dome, with perforated steam pipe, throttle valve in smoke-box. The distinctive differences between these engines is thought to be in the steam ports, those of the "Brown" being 14 in. long, and 1$\frac{1}{4}$ in. wide; those of the others 10 in. long, and 1$\frac{1}{2}$ in. wide.

At the first trial on the Western Division, between the "Brown" and "Virginia," the "Brown" had valves with $\frac{5}{8}$ in. outside lap, no inside lap. On the second trial on the Eastern Division, and also the third on the Western Division, the valves of the "Brown" were changed to $\frac{7}{8}$ in. outside and $\frac{1}{16}$ in. inside lap. The valves of the others have all along had $\frac{3}{4}$ in. lap outside, and cut out $\frac{1}{16}$ in. lead on each end inside. The throw of valves was in both cases 5 inches.

On the first trial between the "Brown" and "Virginia," five round trips were made between Greenbush and Pittsfield, 105 full loaded line cars were taken east, and 175 (a large number of which were empty) were taken west by each engine. The fuel consumed by the "Brown" was 30,850 lbs. of coal, costing $107.97. By the "Virginia" 23,924 lbs., costing $83.73.

On the second trial between the "Brown" and "Adirondack," nine trips were made between Springfield and Boston, 224 cars less 24 from Worcester to Boston were taken east, and 320 less 5 from Worcester to Springfield, west by the "Brown;" and 223 east, and 307 less 3 from Worcester to Springfield west by the "Adirondack." The fuel consumed by the "Brown" was 106,150 lbs., costing $371; by the "Adirondack," 83,090 lbs., costing $290. The average time upon this trial was (going east) to Charlton Summit, 1 hour and 4 minutes each trip in favor of the "Adirondack;" and from Boston to same summit, 1 hour 39 minutes in favor of the same engine.

On the third trial between the same engines, 14 round trips were made between Greenbush and Pittsfield; 317 full loaded cars were taken east and 387 west by the "Brown;" 317 cars east and 372 west by the "Adirondack." The fuel consumed was 86,148 lbs. of coal by the "Brown," costing $301.54; and 69,676 lbs., costing $226.36, by the "Adirondack."

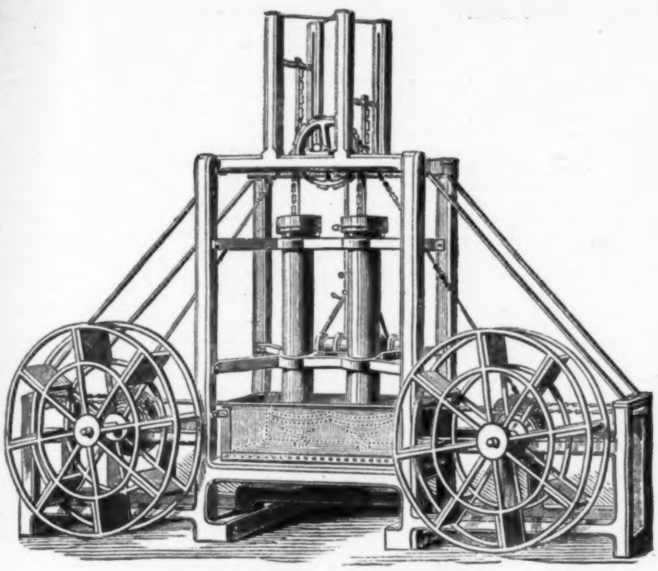
Thus it will be seen that in the 37 days' trial, the mogul burnt 225,148 lbs. of coal, costing $790.54; Springfield engines, 176,690 lbs., costing $600.11. In favor of the latter, 48,458 lbs., and $190.43.

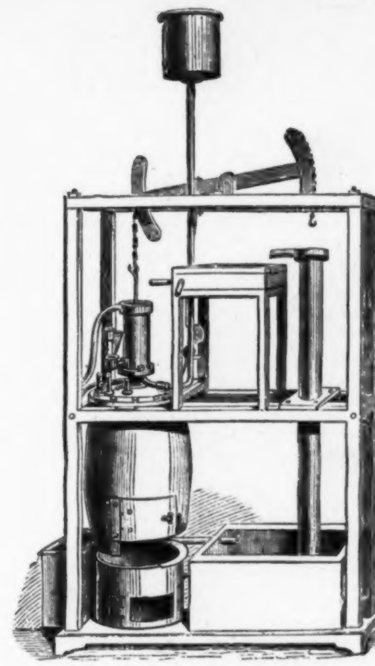
Now the question naturally arises, what has caused the difference in consumption of fuel and consequent expense? No doubt, in this particular, engineers will differ, but here it is not considered to arise from any particular feature alone, but from a combination of them, co-operating to the same end.

First, the Springfield boiler is known to be a free and liberal steamer, with ample steam room. The furnace is wider and shorter, which brings all parts of it within reach of the fireman, so that he can put the coal where he wants to, without throwing it. Then the perforated steam pipe, which takes steam from and directly over the point where it is made, is supposed to have considerable effect upon the dryness of the steam used. The throttle in the smoke-box as close as possible to the cylinders, allowing the steam to accumulate in the pipes and chest to a higher pressure, during the interval when both valves are closed, is believed to act favorably upon the economical expansion of the steam.

The smaller valves and ports are believed to be of great importance; (not that they should be unduly contracted,) "but only this." They should be large enough, for it is considered that a valve unnecessarily large will make an unnecessary friction, and will waste the difference of contents of the port at every exhaust, and will act severely upon the fire.

On the other hand, the competing engine was a mogul, with an additional pair of driving wheels and weight, with a proportional addition of friction of parts. The eccentric rods were short and gave a large addition of lead when linked up. In other respects it is so much like the ordinary standard of engines of its class, that we need not give the particulars. We here leave the engineering world to speculate upon it as they will. And no doubt much good will come of these elaborate and exhaustive trials.—*Chicago Railway Review.*


THE PARENT ENGINE OF STEAM NAVIGATION.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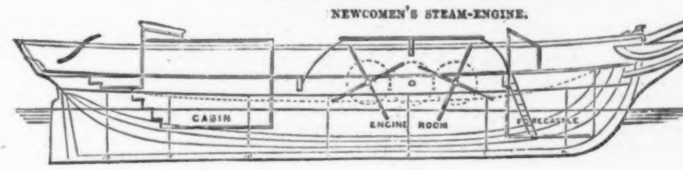
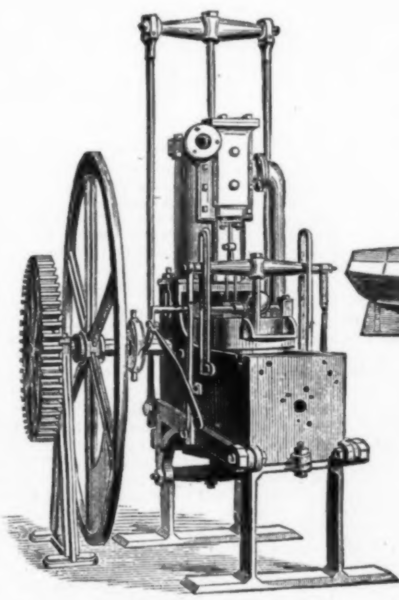
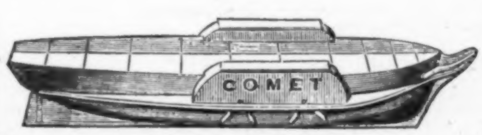
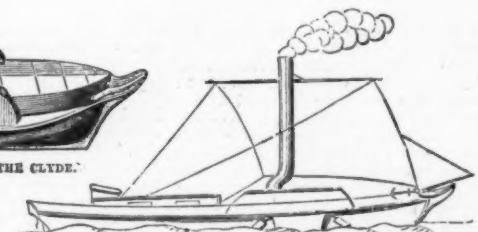
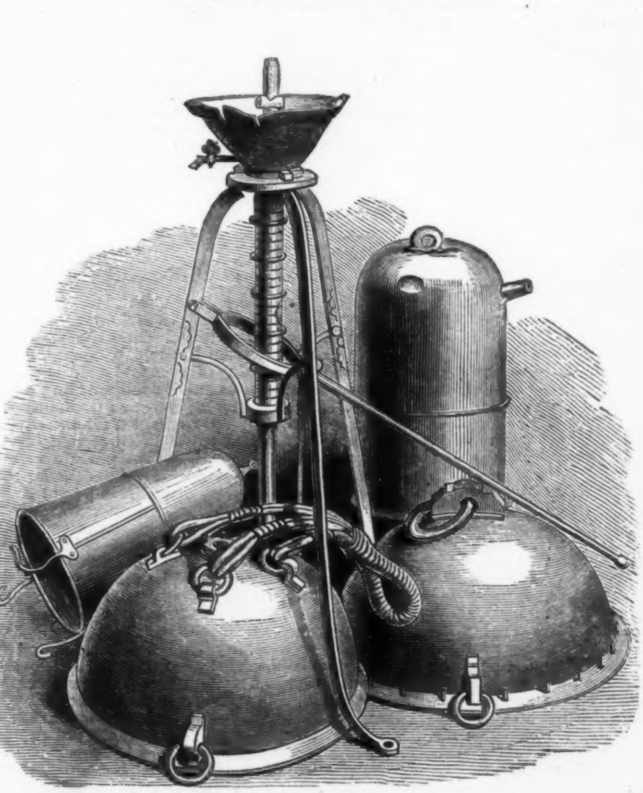


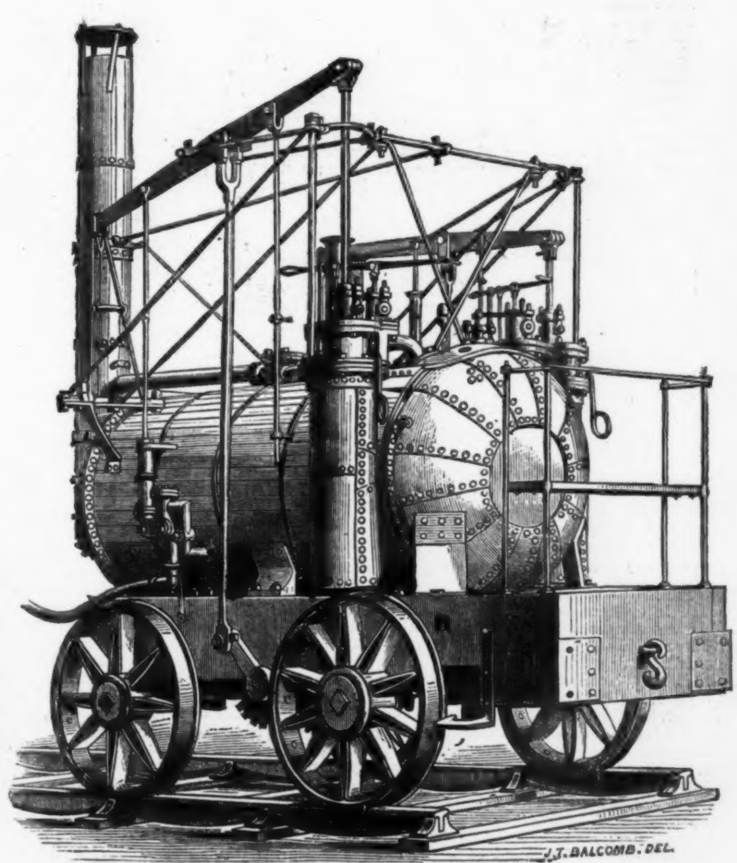

ORIGINAL ENGINE OF THE COMET.



THE COMET, FIRST STEAM-BOAT ON THE CLYDE.


BUILDER'S DESIGNS FOR THE COMET.


OTTO VON GUERICKE'S AIR PUMP AND MAGDEBURG HEMISPHERES.



PUFFING BILLY, 1813.

HISTORICAL TREASURES IN THE SCIENTIFIC LOAN COLLECTION EXHIBITION, LONDON.

EXHIBITION OF THE LOAN COLLECTION OF SCIENTIFIC INSTRUMENTS, LONDON.

THE history of inventions for the application of motive power, more especially of the early steam-engines, is exemplified in the Special Loan Collection of Scientific Apparatus, South Kensington, London, it is sometimes forgotten that steam was employed as a prime mover by Hero of Alexandria, so early as 130 B.C. Hero invented a rotary motion engine; and it is a curious fact that a similar method of producing rotary motion was suggested by Kempel in the last century; and there is also a patent, dated June 10th, 1791, for carrying out the same principle. In 1543 a naval officer, Blasco-de-Garay, exhibited before the Emperor Charles V. of Spain, at Barcelona, a steam-engine which gave motion to a vessel without the assistance of sail or oar. This was the first distinct forerunner of the modern steam engine. In 1629 there was published at Rome a work containing an account of a machine by Giovanni Branca; this consisted of a boiler with a safety-valve, having a pipe like a tea-kettle, which conveyed the steam with considerable force against a float wheel, driving it round with a rotary motion, which was communicated to the pestals of two mortars. The next notice we find is that in the published work of the Marquis of Worcester, in 1663, "The Century of Inventions." He describes his own invention as a "fire waterwork." In 1690 a celebrated Frenchman named Papin suggested the piston as part of the steam-engine. In 1698 Captain Savary obtained a patent for a steam-engine, which was the first introduced to raise water. In 1713 Newcomen and Cawley invented and constructed engines on Papin's principle. This is called the atmospheric engine, because its power is derived from the pressure of the air, the steam being used merely to form a vacuum. Newcomen's engine was the first really efficient one which could be worked profitably or safely; but, by the calculation of Watt, three times too much steam was expended, being a loss of 75 per cent in power. Watt's chief improvements in the steam-engine were that he excluded the air from the cylinder, made the engine double-acting, and condensed the steam separately. The last improvement was suggested to his mind in the winter of 1763–4, while repairing Newcomen's engine belonging to the Natural Philosophy class of the University of Glasgow. Of this machine we give an illustration.

In the history of steam navigation there is a British patent obtained by Mr. Jonathan Hulls, and dated Dec. 21st, 1736. The title of it is "a new-invented machine for carrying vessels or ships out of or into any harbor, port, or river, against wind and tide, or in a calm." This, however, was nothing more than a tow-boat moved by steam. Our second illustration is that of the parent engine of steam navigation, constructed by William Symington, with the aid of Patrick Miller and James Taylor. It was first used on the small lake of Dalswinton, near Dumfries, in 1788, and propelled a vessel at the rate of five miles per hour. The next engraving represents the original engine of Henry Bell's steamboat, the Comet, which was the first steam-vessel in Europe used for the conveyance of passengers and goods. This vessel was 42 ft. long, 11 ft. broad, and 5 ft. 6 in. deep. Our next two illustrations are reduced *fac similes* of the builder's original diagrams of the Comet. Below the original diagrams, as placed in the exhibition, is an autograph letter attesting their authenticity:—"Glasgow, Nov. 9th, 1833.—Received this day, from Mr. John Wood, shipbuilder, Port Glasgow, the original draught from which the Comet steam-boat was built, she being the first steam-vessel ever built in Europe that plied with success on any river or open sea. At first she had two sets of paddles on each side of the vessel; this was afterwards abandoned for one wheel on each side. The power of the engine was about four horses, and her greatest speed, under favorable circumstances, about five miles an hour. This upon the authority of Mr. Wood, the builder. Built at Port Glasgow, for Mr. Henry Bell, 1811.—R. NAPIER, Vulcan Foundry."

The following is a copy of the original advertisement:

"STEAM PASSAGE BOAT. THE COMET. Between Glasgow, Greenock, and Helensburgh, for passengers only. The subscriber having, at much expense, fitted up a handsome vessel to ply upon the RIVER CLYDE BETWEEN GLASGOW AND GREENOCK, to sail by the power of wind, air, and steam, he intends that the vessel shall leave the Broomielaw on Tuesdays, Thursdays, and Saturdays, about midday, or at such hour thereafter as may answer from the state of the tide; and to leave Greenock on Mondays, Wednesdays, and Fridays, in the morning, to suit the tide.

"The terms are for the present fixed at 4*s.* for the best cabin and 3*s.* for the second; but, beyond these rates, nothing is to be allowed to servants or any other person employed about the vessel.

"The subscriber continues his establishment at HELENSBURGH BATHS the same as for years past, and a vessel will be in readiness to convey passengers in the Comet from Greenock to Helensburgh.

"Passengers by the Comet will receive information of the hours of sailing by applying at Mr. Housten's office, Broomielaw; or Mr. Thomas Blackney's, East Quay Head, Greenock.

"Helensburgh Baths, Aug. 5, 1812. HENRY BELL."

Mr. Bell presented this invention to the British Government in 1800, 1803, and in 1813. It was declined as being of no service. He offered it to all the Emperors and crowned heads of Europe, as well as to the American Government, which last put it into practice in 1806. The next engraving is from a small model in the exhibition, and conveys a further idea of its appearance.

THE OLDEST LOCOMOTIVE, THE "PUFFING BILLY."

There is also to be noticed "Puffing Billy," the oldest locomotive in existence—the first which ran upon a smooth rail. It was constructed under William Hedley's patent, and was used at Wylam Collieries, near Newcastle-on-Tyne. It commenced regular working in 1813, and was kept in use till June 6, 1862. The earliest engine-drivers were born or trained at Wylam, the birthplace of "Puffing Billy." Stephenson's Rocket, of which we have before given an illustration, is among other interesting objects in the present collection.

We may add a few words, in conclusion, respecting locomotives, past and present, their cost and capability of work. Forty years ago the expense of drawing a stage coach was about two shillings per mile, but cattle food was cheaper then. The early locomotive, such as "Puffing Billy" or Stephenson's "No. 1 Locomotion," cost for building about £500, and would haul twelve wagons at a speed of eight miles per hour. "Locomotion" was of sixteen nominal horse-power. A first-class locomotive of the present day costs from £2500 to £3000. One of the engines exhibited at the Railway Jubilee, at Darlington, last year, can attain a speed of sixty miles per hour with fourteen passenger carriages; the nominal horse-power is 700. On that occasion the Great Northern Railway sent an express engine capable of a speed of seventy miles per hour, with twenty-four coaches attached. The present average expense of a locomotive, including repairs, is about 10*d.* per train mile. No wonder, when we think of the capabilities of the steam-engine as compared with horses, that the old coaches were driven off the road by such competition.

INSTRUMENTS AND PNEUMATIC MACHINES.

In experimental philosophy there have been few more interesting events than the discovery of a complete vacuum. Torricelli, the pupil of Galileo, produced a vacuum in 1644, by means of a glass tube filled with mercury; this was inverted into a basin of water, the mercury falling, the upper chamber became empty, and having in it either an exhausted bladder, or bell with hammer attached, the bladder was distended, the hammer struck the bell. These were important results. Otto von Guericke was much impressed with these facts, and, after numerous failures, he constructed the first pneumatic machine which worked regularly, the subject of our remaining illustration. These are Otto von Guericke's original air-pump (5 ft. high); the two large Magdeburg hemispheres of copper (26 in. diam.); the other two are receivers. In Father Schott's "Technica Curiosa" there is an account, and an elaborate engraving, of an extraordinary experiment in the year 1656, where these two hemispheres having been joined, exhausted of the air within to one hemisphere, there were successively harnessed six, eight, ten, twelve, horses opposed to a like number attached to the other, which, though urged by whip and cries, could not with all their combined force succeed in effecting a disjunction. Robert Boyle, a clever English philosopher, profiting by the labors of Von Guericke, and assisted by Hooke, constructed the first English air-pump, in 1658.—*Illustrated London News.*

THE BRITISH ASSOCIATION.

AT the recent meeting the number of papers read in the several sections was very large.

STRENGTH AND FRACTURE OF CAST IRON.

Mr. W. J. Millar read a paper "On the Strength and Fracture of Cast Iron." The author described the results obtained in testing cast-iron bars 36 inches span, 2 inches deep, and 1 inch broad. The bars usually broke with straight fractures, but occasionally curved fractures were observed. The average breaking strength of 29 bars showing straight fractures was 3584 lbs.; the average strength of 25 bars showing curved fractures was 2551 lbs. Some results of "set" and deflection were given, showing that for successive applications of the same load, 2800 lbs., there was a decrease of set. The principal object aimed at by the author of the paper was to show the relation existing between form and position of fracture, straight fractures taking place at or close to centre of span, and curved fractures occurring at points more or less removed from centre of span.

CEMENT AND THE STRENGTH OF CONCRETE.

Mr. G. F. Deacon contributed papers on "The Form of Blocks for Testing Cement," and on "The Strength of Concrete as affected by delay between mixing and placing *in situ*." In the course of his remarks he said he believed that Portland cement was the best cementing material which could be used in contact with acids of different kinds. As to cracks, which gave so much annoyance in cements, he thought they were due to two things, one being the quality of the cement used, and the other was the homogeneousness of the mixing which was adopted; and in most cases he believed the cracks were traceable to a defect in the latter arrangement.

STOBCROSS DOCKS.

Mr. James Deas, engineer to the Clyde Trust, Glasgow, read a paper descriptive of the Stobcross Docks, chiefly with the view of giving the Association some information regarding the novel system of quay wall substructure now being carried out in the construction of these docks. In 1845 35 acres of ground were purchased by the trustees at Stobcross, and under Acts of Parliament subsequently obtained docks are now in course of construction, which will afford 3342 lineal yards of quay, fully 27¼ acres of quayage, 33¼ acres of water space, will be 20 feet deep at low water, and will comprise three basins—one 270 feet wide, one 230 feet wide, with a quay between them 190 feet broad, and an outer basin 695 feet wide at its widest part. The docks will be tidal, and will be approached by an entrance 100 feet wide, which will be crossed by a swing-bridge now in course of construction by Sir William Armstrong & Co. There will be four coaling cranes, to lift 20 tons each, and grain stores on the north quay of docks, all of which, together with the swing-bridge, which will be constructed to carry 60 tons of a rolling load on any part of its roadway, will be wrought by hydraulic power. The north quay wall, so far as constructed, being founded on boulder clay, was of the usual description; but in all the other walls, as also the seat for the swing-bridge, concrete cylinders had been adopted in consequence of the bed being quicksand or gravel. In proceeding with the construction of the substructure a trench has been cut on the line of the quay wall. On the bottom of this trench cast-iron "shoes" were placed. Corbellated rings were then inserted on the shelf of the shoe. The remaining rings forming the cylinder were next set, one a-top of the other, in Portland cement. This completed, the sand and gravel were cleared out, the group sunk, and each cylinder fitted to the top with Portland cement concrete; and on this foundation the quay wall was built. At the close of his paper, Mr. Deas mentioned that the first of the ground acquired for the docks was bought in 1845, at 6s. 6d. per square yard, while the last had been acquired in 1872 at 35s. The total cost of the docks, when fully equipped, would, he stated, be £1,500,000.

A paper by Mr. T. S. Hunter, a contractor for a large portion of the Stobcross Docks, was afterwards read. It dealt chiefly with the construction of dock and quay walls, the foundations of bridges, subways or tunnels, sewers, and works of a similar nature, as also with the means used to facilitate them. The author treated with some detail of the materials used in such operations, and the mode or modes of conducting, drawing frequently for his illustrations upon a series of diagrams which were exposed on the wall. He concluded by saying that piles or cylinders were apt to be assailed by freshets, inducing a gouge which has a tendency to undermine the structure, besides causing a commotion disadvantageous to discharging and loading vessels alongside of quay walls, and the navigation was also affected by it.

Mr. Deas, in reply to questions, said that to the Clyde Trustees belonged the honor of having been the first to adopt concrete cylinders in lieu of iron and brick. In reference to this matter, Mr. Hunter, contractor, took objection to the cylinder system, as being liable to be assailed by freshets and the run of the river. Mr. Deas replied that cylinders were virtually a smooth surface, and offered no objection to the flow of the river. It was, however, to be borne in mind that the cylinders terminated at 3 feet below low-water level, and that the whole surface presented to the run of freshets was a smooth wall.

The President said that in the present state of the works referred to it was not easy to pronounce on the matter at issue. There was no doubt, however, that a smooth quay wall offered very much less interruption to the flow of a river than a rough one. That fact, however, was not of so much consequence in a river like the Clyde, where the ordinary effect of the river was deposition and not absorption.

SPRING-FENDERS FOR PIER-HEADS.

Mr. Mortimer Evans, C.E., F.R.A.S., read a paper "On the Arrangement of Spring Fender Piles for the new Iron Pier at Craigmore, near Rothesay," at present in process of completion for the Craigmore Pier Company. Mr. Evans explained the structure as follows: The pier-head front on which the fenders are fixed is composed of three longitudinal heavy girders, and to the uppermost of these (which also supports the deck or planking) the top ends of the fender piles are fixed by a bolt passing through them. To the outside flange of the second girder a bolt is also attached, passing through these fender-piles at about six feet lower, or about half way down their whole length, and the inner flange of this girder abuts on a series of steel-rail springs, twelve in number, 36 lbs. in weight, and 10 feet long, fixed at their upper and lower ends in cast-iron shoes to the supporting piles of the pier itself. The lower girder serves to receive the bottom ends of the fender piles when thrust home by blows from calling steamers. By this arrangement the steel springs must bear hard upon the pier-head piles before any blow is ordinarily sensible to the pier-head itself, and the force required to effect this is about 20 tons. The model showed clearly the peculiar arrangements adopted, and as the actual pier itself is now so near completion it will be a matter of some interest to learn if all the expectations of the engineer are realized. If this be the case, a marked advance will have been made in the right direction, as the rapid running alongside of steamers in bad or any weather, without fear of injury either to the vessel or pier, is a thing hitherto not accomplished and much to be desired. Mr. Evans further mentioned that he has rendered this pier all but indestructible by encasing the iron piles with pipes of fireclay, and securing them in with cement. The iron is thus the strength or backbone of the structure, and the cement the indestructible element. The parts exposed above low-water mark are protected with zinc.

FIREBRICKS.

Mr. James Dunnachie read a paper on this subject, viewed from the brickmaker's standpoint. The metal smelter observed that his furnace, unlike his other buildings, were continually melting and crumbling away. This had become a serious item in the cost of production, and there were indications of an increased chemical interest in the subject, which, with the co-operation of the consumers and manufacturers of firebricks, might ultimately lead to results that would meet all the wants of practical metallurgy. To get a really good furnace they must first procure the best material for its construction, but after that much depended upon how it was built. The firebrick trade of Glasgow can not lay claim to the antiquity which belongs to Stourbridge or Newcastle. It only dates some forty or fifty years, but it is healthy, and even already well grown. The quantity of firebricks made in the Glasgow district, which is almost exclusively comprised in the counties of Lanark, Renfrew, and Ayr, will amount in ordinary times to eight millions. In addition to this there is manufactured an enormous quantity of sanitary pipes, gas retorts, and other articles in fire-clay, both useful and ornamental. The fire-clays wrought in the neighborhood of Glasgow are situated geologically in the upper coal series and limestone series, taking the Roman cement as the dividing line, or, according to the Ordnance geological map, in the millstone grit. They are found at all depths—from the surface opencast workings to pits of forty or fifty fathoms. The process of firebrick making is very much alike all over the west of Scotland, and indeed everywhere else when fire-clay is the material employed; but as it is necessary to be clear and connected, he followed the process as employed at the Glenboig Star Works. Having described the process at great length, he asked, in conclusion, how they were to have cheaper and better firebricks? The cheapening of price would be no answer. What was required was a superior quality, so that the price, whatever it may be, will be found to be cheap when viewed in relation to the service rendered. Something might yet be done to economize fuel, and machinery might yet reduce the item of wages and at the same time improve the condition of the workman; but if the requirements of modern metallurgy are to be fully met, it must be principally by the improvement of our furnace materials.

MANUAL FORGING SUPERSEDED.

AT the recent meeting of the Iron and Steel Institute, Leeds, Mr. J. O. Butler, of the Kirkstall Forge, near Leeds, read a paper "On the Hydraulic Forging and Stamping of Malleable Iron on the 'Systeme Haswell' of Vienna." The writer states that "the pressing of iron into a mould, or matrix, to give shape to various articles by the aid of the screw-press, has also been practised for many years; the steam-hammer has likewise been brought into requisition for the same purpose, but to a limited extent only. Reciprocating blows from a steam-hammer, it is found, do not produce or accomplish satisfactorily the kind of pressure necessary for forcing the atoms or molecules of iron, in an incandescent state, into all the interstices of a mould, where intricacy and accuracy are desired. This, however, can be done effectually by the inexorable thrust of a hydraulic or hydrostatic 'squeeze.' And this leads us to the subject of the paper now before you. We believe that Mr. Haswell, of Vienna, was the first to bring into practical and useful operation the 'squeezing' of malleable iron at a welding heat into shapes and uses, as they are technically called, previous to their being manipulated by the smith and fitter. Some years before Mr. Haswell's patent of the machine, or tool, now under consideration was designed, hydraulic power had been made use of for forging or pressing malleable iron, both with and without the aid of an accumulator; but it is to Mr. Haswell that we are indebted for the improvements which make the hydraulic press a tool of general use. The machine or tool that he has produced is simply the adaptation of the hydraulic press, on the principle of Bramah, with an arrangement peculiar to Haswell, whereby a 'squeeze' can be given, either reciprocating or in one continuous thrust, until the piece operated upon acquires the desired shape. The pieces on the table are samples of what are produced: No. 1 is a sector of a 12-spoked wrought-iron locomotive wheel, showing three spokes with their portion of rim and boss pressed out of the solid slab. No. 2, locomo-

tive cross-head ditto. No. 3, ditto (double) ditto, ditto. No. 4, outside crank with its pin, ditto. No. 5, piston-rod socket, ditto. No. 6, locomotive axle-box, ditto."

A long and interesting discussion followed, in the course of which Mr. J. T. Smith, Barrow, stated that, judging from the results produced by Sir Joseph Whitworth in his operations for dealing with molten steel, he should come to the conclusion that, however important Mr. Haswell's practice and experiments may have been, they were in a fair way of being superseded by his (Sir Joseph Whitworth's) plan.

Mr. Greig, Leeds, said by the Haswell process the fibres were got in the exact line the article was bent. In the case of wood, the fibre was always found in the bend of the tree. If the same thing could be done in iron they will attain the maximum strength.

Mr. Cowper, London, said a few years ago the late firm of Fox & Henderson carried out some experiments in reference to squeezing iron into shape. It was an invention by Sir Charles Fox, for the use of hydraulic presses for squeezing iron. He (Mr. Cowper) added to it a hydraulic reservoir having a dead weight upon it, so that when they wanted to get a stroke of the hydraulic press they had nothing to do but open a valve, and they got the stroke quickly. He could not help thinking they would find that the use of the hammer, where very large masses had to be dealt with, would become as much a thing of the past as he hoped the use of the falling weight had now become in testing rails.

Mr. Carbutt, Bradford, said he had seen Mr. Haswell's machine at work in Vienna, and had come to the conclusion that it was the right way to do work. The only objection he saw to it was the dies, which were expensive, and which absorbed the heat from the metal, and made it cold; but if the press were only heavy enough and strong enough to do its work, he believed the difficulty of the dies would be overcome.

Mr. Paget said: Having been enabled, for several years, to study at Vienna Mr. Haswell's processes, and having lately examined Mr. William Sellers' work of a similar kind at Philadelphia, as also at Herr Borsig's works at Berlin, I may, perhaps, be allowed to say a few words. Strictly speaking, it is not forging that is done in this way, but rather swaging. The dead pressure of the hydraulic press allows cast-iron swages or moulds to be used of sizes that would be broken up by the percussive action of the steam-hammer. The Haswell press merely does for large forgings what the drop-hammer—so largely used for the details of small-arms and sewing-machines—does for small forgings. The slabs are always more or less hammered before being put into the moulds. Similarly, as with swages and all special tools, it can only be used to pecuniary advantage for work in which there is repetition. In such uses the saving is very great, amounting, for such uses as locomotive cranks, to fifty and even more per cent, as compared with forging under the hammer. The most efficient way of using the Haswell press would be to set it up in connection with puddling furnaces. Beginning at the presses of Mr. Haswell at Vienna, at Herr Borsig's in Berlin, Krupp's, of Essen, Baron Dietrich's, of Niederbronn, Mr. Haswell's plan had been carried out and developed during the last fifteen years, realizing large profits, and turning out such work as that shown before the meeting.

Mr. Walker, of Leeds, believed that where there was a great repetition of work the Haswell press was a very valuable machine, but without the repetition of work it would not pay. He was quite satisfied that the steam-hammer just now was altogether an inadequate tool for dealing with a 15-cwt. ball. He would say that it was quite impossible to deal with it. He believed it was perfectly practicable, and very easy to accomplish, to make a press that would deal with a 15-cwt. ball, and that would in two or three seconds make a perfectly sound, and what was called on the previous day, "homogeneous" ball.

Mr. James Kitson, Jr., said some of them had yesterday an opportunity of seeing some of the remnants of the barbarous way of forging iron that had been spoken of. Practical proof was the best in those matters, and he would ask any gentleman if he thought the web of a crank-axle could be produced with the grain of the samples that they saw yesterday by any method of squeezing in the hydraulic press. He himself did not think so; on the contrary, he thought it was impossible to build up the iron as they built it up by that means.

Sir Joseph Whitworth said that by applying great pressure to a column of metal, its length was diminished one eighth of its whole length in less than five minutes. The air-cells were thus expelled. It had been a dangerous and difficult process to carry out, but it was now quite successful, and he was preparing to carry it out on a much larger scale. It might be interesting to the meeting if he gave some particulars respecting two twin screw-shafts which he had completed lately for the ship "Inflexible." They were 283 feet in length, and their weight was 63 tons. The weight would have been 97 tons, but by the use of compressed steel 34 tons had been saved in the two shafts. The strength of the shafts was 40 tons to the square inch, and the ductility—that is, the power of pulling an inch bar asunder—was 30 per cent of the length. They were 17 in. in diameter, and were cast hollow. They had a 9 in. hole through them. He found it was desirable to get the pressure on as soon as possible after the metal was poured into the mould when it was at a white heat. His press had a power of 8000 tons. He had not employed the press in forging iron. What he had done was entirely with the fluid compressed steel, so that he could not say any thing about the application of hydraulic power to the forging of iron. But he was of opinion that the value of hydraulic pressure in forging was in proportion to the size of the mass; as far as their experience had gone, the larger it was the more beneficial was the hydraulic press. The pressure they put on the fluid steel was, practically, about 6 tons per square inch. He had made the experiment of putting on the enormous pressure of 20 tons to the square inch, and found they could not improve the metal so treated at all, or by any thing they did, the atoms were pressed so close together. In the shafts he had spoken of they generally put about 6 tons per square inch on the fluid metal in order to expel the air and the gases.

Sir John Alleyne said that they could not produce a steel that should have 30 per cent of ductility without pressure; it would be full of air-cells without. If they wanted tool steel where they had not so much ductility, they might then get three fourths, say, of the length with their ingot comparatively sound, and the pressure in that case would be of very little value; but if they wanted to get steel which should be suitable for manufacturing purposes generally then they could not produce it at all with the amount of ductility required without the squeezing process. There was provision made for the escape of the gases, and there was considerable flame burning from them during the time of their escape.

Mr. Snelus could not allow to pass unchallenged the statement that they could not get that ductility without compressing the material. He had over and over again made steel which bore exactly the same tensile strain that Sir Joseph Whitworth had mentioned, and gave exactly the same amount of ductility in a cast ingot. It had of course been rolled out ultimately, but the cast ingot was so far sound that its strength was enormously increased, and, of course, the strength of the finished article was increased in proportion.

Sir Joseph Whitworth: And have you been able to accomplish that in very large masses, say 5 or 6 tons?

Mr. Snelus said they had. Messrs. Bolckow, Vaughan & Co., he thought, had a great number of steel boiler-plates made out of that steel on their ground now, and a great many of those plates had stood a very high test, but they did not keep it up to that, because, as a rule, the users of steel liked a low tensile strain, and it does not follow that because it had a high tensile strain, that it might not also have a high amount of extension, as he (Sir Joseph Whitworth) had obtained.

Mr. J. O. Butler, in the course of his reply, stated the advantages arising from the use of hydraulic pressure, and remarked that some time ago, when he wanted a 10-ton steel cylinder for a press, he found it impossible to get it cast in England, and had eventually to procure it from Westphalia.

After Mr. Joseph Whitley and Mr. J. T. Smith had repudiated the statement that such a steel cylinder as that described by Mr. Butler could not have been cast in England ten years ago, the chairman remarked that he thought the Institute would agree with him that Mr. Butler had not proved that assertion. But even if the assertion had been correct, they could now produce any thing that could be done elsewhere. Mr. Butler, however, deserved a hearty vote of thanks for his paper.

PLANISHED STRAIGHT ROUND BARS.

AT the recent meeting of the Iron and Steel Institute, Leeds, a paper was read "On the Straightening and Planishing of Round Bars, as Practised by Patent Machines at Kirkstall Forge," by Mr. Edmund Butler, of the Kirkstall Forge, Leeds. The author said that in spite of all the care and skill that can be exercised in the rolling-mill, the ordinary round bar leaves it as a somewhat imperfect and but approximate cylinder, neither truly round nor truly straight. It is a comparatively easy matter to straighten a bar which is bent in one uniform curve from end to end, but it is the short bends, crooks, or dog-legs, which are the main difficulty, the presence or absence of which makes a good or bad round bar; and these, which appear to be more or less inevitable in all rolling, can only be effectually removed while the bars are still hot, for with cold straightening there is always a tendency in the bars to revert to their original form when the skin is removed in the lathe. The production of a machine to accomplish the desiderata now in question has long occupied the attention and taxed the ingenuity of the ironmaster, particularly for the larger sizes, and many schemes have been initiated and tried, but the machine now under notice is the only one known to the writer which effectually removes dog-legs, and produces round bars sufficiently straight to be used for most ordinary purposes without being turned in the lathe. The original idea of which this machine is an embodiment is due to Mr. James Robertson, of Glasgow, though the same idea seems to have occurred almost simultaneously to Mr. G. W. Dyson, of Sheffield, and it is the general arrangement of the latter which has been adopted, though, since it passed out of the hands of these gentlemen, many improvements and additions—the results of practice and experience—have been made, which have given it the success it has now attained. The bars are passed while still hot from the rolls between two revolving disks having bevelled faces, which, when brought together so as to compress the bars between them with the degree of force thought necessary, rotate them, and at the same time traverse them forwards, also by a mechanical arrangement backwards, so that the whole length of the bars is acted on by one continuous movement, and the bars come out straightened and planished. In doing this, moreover, two other important results are produced, the most palpable of which is that the scale, instead of being rolled in, as might be supposed, is entirely removed, and the surface is made smooth. The skin is brought to a very high degree of cleanness and smoothness, so much so that a mere rubbing with emery cloth, or if the bar be put into the lathe with emery stick, polishes it as though it had been turned and polished in the ordinary manner. Some small samples are exhibited, with one end left blue, as from the machine, and the other end polished as just described, in order to show the inappreciable difference in diameter between the two portions. This is already done practically, and shafting is now running, which has been put up without being turned, while other shafting, after being put up in the same manner, has been polished in its place; and, again, the bars have been put into the latter and finished with the file and emery stick without being turned. To carry the finishing process still further, if the bars, after being allowed to go cold, are passed again through the machine several times, the blue skin disappears, and the bars come out actually bright. The other effect of the machine before referred to, and that a very important one, is that, by the action of the disks, the bars are slightly compressed, and consequently strengthened. Mr. David Kirkaldy has made some experiments to test the torsional strength; and, in order to make proper comparisons, bars, after being rolled in the ordinary way, were cut in half, one portion being left with the ordinary finish, and the other portion being put through the machine; and it was found that up to the point of elastic stress the machined bars had gained 20 per cent in torsional strength.

With a view to render as economical as possible the operation of polishing these bars bright with emery, and without the expense of centring and putting in the lathe in order to use the emery stick, a machine has been constructed by Mr. Robertson to rotate and traverse the bars across the face of an emery wheel; and this first machine is now at work at Kirkstall Forge.

MANUFACTURE OF GLASS IN CONNECTION WITH BLAST FURNACES.

AMONG the papers lately read before the Iron and Steel Institute, Leeds, was one by Mr. Bashley Britten, of Redhill, Surrey, "On the Utilization of Blast Furnace Slag with its Heat for the Manufacture of Glass." After calling attention to the qualities and to the enormous supply of slag available for purposes of utility, the writer proceeded to observe that for perfectly white glass, such as crystal, it is obvious that slag can be of no value at all, in consequence of the amount of iron it contains, which can not be eliminated, and would produce a green or amber color. Still iron is present more or less in all glass. The analyses of specimens of the window glass of commerce exhibit as much as from one half to one and a half per cent, it being possible to neutralize its effect to a considerable extent by decoloring materials. For all glass in which a tinge of color is either needed or is not detrimental—and this includes an extremely large proportion of all that is made—a little iron does no harm; it is, in fact, often introduced as an important element, for it is capable of replacing other flux, and so lessening the amount of alkali which would otherwise be required. In order to produce the glass described by the author the slag can be used in its heated state just as it leaves the blast furnace. He showed that 175 parts or tons of glass would be produced with the following economy. One hundred tons of it would cost an ironmaster nothing. Instead of the labor of mixing and handling in the usual way the whole quantity of the material, only 75 tons would have to be lifted into the furnace. The only ingredients to be bought are 65 tons of common yellow or red sand, to be had anywhere at a mere nominal price, and 10 tons of common sulphate of soda, which may be bought or made for about 20s. per ton. The necessary fuel would be limited to what is needed beyond the surplus heat of the slag to raise only three sevenths of the glass to the required heat; and it is a question whether the greater part of even this might not be saved by bringing down some of the spare gases from the blast-furnace and employing them with regenerators; if needed, they could easily be enriched with a little added carbon. Against these items there would be a set-off for the cost of removing the 100 tons of slag, which must otherwise be thrown away. Besides this, another and considerable saving would arise from the wear and tear of the glass furnace being lessened, in consequence of four sevenths of the materials going into them being already fused. Under such circumstances, the total cost of the glass in a melted state ready for working is seen to be so extremely small that it is hardly safe to venture to express it in figures; it scarcely amounts to the value of the commonest bricks per ton. A cheaper glass than even this can be made by using a larger proportion of slag and less sand, thereby necessitating less fuel to effect combination. In fact, the slag from some ore is sufficiently silicious in itself to be converted into a black, or dark green, or amber glass. With the simple addition of soda and a little arsenic, which are taken up immediately, it becomes transparent and perfectly workable, and would be useful for many purposes, such as slabs, tiles, or other things for outdoor work; but it would not do for bottles or any utensils for holding powerful acids, as its want of silica renders it liable to be corroded. It need hardly be stated that glass of much superior quality to that indicated above may be produced. In regard to all other essentials, such as clearness, brilliancy, strength, plasticity in working, power of resisting acids, and the capability of being cut with the diamond, it may be made equal to any other. The practical question has to be considered of how far it is possible to combine the manufacture of glass and iron without in any way interfering with the necessary continuous operations of the blast-furnace, for this, as a matter of course, is absolutely essential. Blast-furnace works where pig iron only is made frequently stand in pairs in isolated situations, with plenty of space around, on which glassworks may be erected on any scale; and in many instances they might be built close up to the sides of the furnaces, and extending laterally away from the pig bed. In that case the slag might be run directly into the glass furnace, on the well-known plan of Mr. Siemens for continuous founding and working. Where there is insufficient room for this, the glassworks might be at some distance, and the slag could be collected and conveyed to them in a state of fusion in large covered iron ladles on wheels, similar to those used in some Bessemer steel works, where the molten iron is carried upwards of a mile to be poured into the converters. These observations are founded on the results of a long series of experiments extending over the greater part of the last three years, in which the author has endeavored to test, in every way open to him, the soundness of his conclusions before submitting them to criticism. The glass thus made can of course lay no claim to high quality in point of color; still this is its only inferiority, and no doubt it may be improved in this respect.

Mr. Pattinson, Newcastle, remarked that glass could undoubtedly be made from slag, but there was the likelihood of inconvenience in having glassworks attached to ironworks. The specimens made and exhibited by Mr. Britten appeared to be a nice kind of glass suitable for the manufacture of bottles and sheet glass. Mr. J. G. Snelus said he had been analyzing the slags at the West Cumberland Works lately. He thought that in all probability they could make simple articles very cheaply from slag, and especially that glass for horticultural purposes might be made on a large scale. Mr. Cowper remarked that it would be inconvenient to have glassworks attached to blast-furnaces, but he believed there was a great field for the manufacture of glass for horticultural purposes.

Mr. Smith, Barrow, thought this was more a question for glassmakers than for ironmasters. He asked why glassmakers, knowing the generosity of ironmasters, did not erect works in the neighborhood of iron furnaces. For himself he would be willing to give any glassmaker, if he came to Barrow, three million tons of slag if he only took it away from the furnace.

Mr. Britten said it had not appeared to any one to use the slag while hot. This was no use to take the slag when cold, crush it down, and re-heat it.

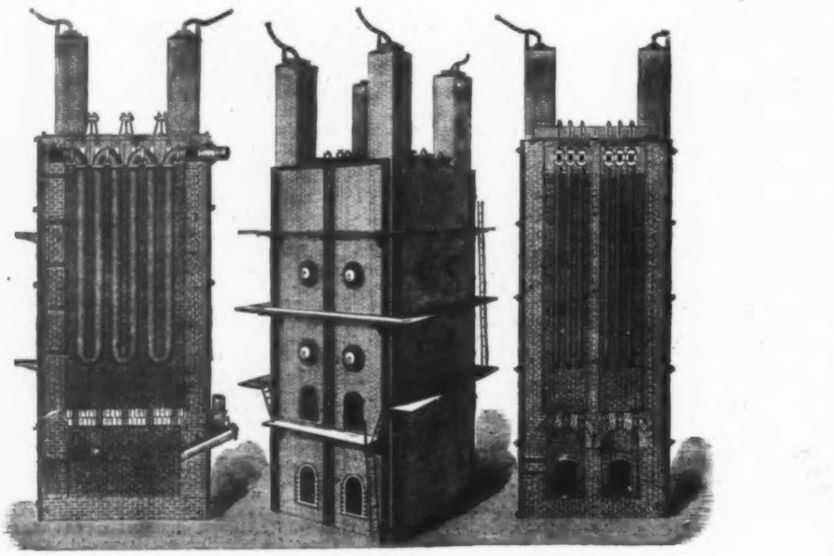
THE LONGEST BRIDGE IN THE WORLD.

A PIECE of engineering enterprise of great magnitude and importance is just now making rapid progress, namely, the new viaduct across the estuary of the Tay. The first stone of the Tay bridge was laid on the Fifeshire side of the Tay in the month of July, 1871. The estimated cost of the undertaking was from £200,000 to £220,000. The object of the undertaking was that of connecting the important manufacturing town of Dundee with the North British Railway Company's branch between Edinburgh and Tayport. The length of the bridge is 10,321 feet, and in shape it is not unlike the letter S. It is the longest bridge over a running stream in the world. On this account its construction was looked upon as one of the most important engineering works of recent times. Nor was it in respect of length alone that it claimed to be unique, and threatened to tax all the constructive resources of its builders. It was beset with even greater trials on account of the Tay being a tidal river, liable to enormous floods and exposed to blasts of wind from east to west, which seemed likely not only to hinder the progress of the work, but to destroy such progress as had actually been made. For a long time very little progress was made in the work of construction on account of the experimental character of the operations and the frequent accidents that befell.

IMPROVED HOT-BLAST STOVE.

THE engraving represents one of Mr. Weimer's suspended pipe hot-blast stoves, designed and constructed at the Weimer machine works, Lebanon, Pa., the most important feature of which is the suspending of the pipe from the roof of the stove, and the absence of the usual bed-pipes or mains.

The pipes are **U**-shaped, with the upper ends turned outwards and flanged. The cross section of the pipe is a parallelogram with semicircular ends, the internal dimensions being 4 in. by 12 in. and external 6½ in. by 14½ in., except at the curve of the **U**, where the metal has been increased to 1½ in. in thickness, the excess tapering gradually until the uniform thickness of 1¼ in. is met about 3 in. from the bottom of the pipe; this additional thickness of metal is given to compensate for the action of the impinging gases and the more rapid oxidation of this part of the pipe. The flanges are planed to a true surface and secured to each other with key bolts; the pipes are cast from 12 ft. to 20 ft. long as may be preferred, and have collars formed on their upper end immediately below the flanges for the purpose of giving support to the roof, which is made of brick cut to fit between the pipe. The inlet main rests on the top end wall of the stove, and is provided with an inlet branch and three pipe branches; three rows of **U** pipe (three to a row) convey the air to be heated from the inlet main through the first heating chamber to the transfer main, resting on the opposite side of the stove, where it is transferred to a similar lot of pipe, which convey it through chamber No. 2 to the outlet main. Each stove has two independent combustion chambers communicating each with its separate pipe chamber for the purpose of enabling the attendant to throw as much gas, and consequently heat, into the "cold" side of the stove as may be desirable, and to check a too great accumulation on the hot side. Each pipe is suspended by means of two key bolts to a 15 in. wrought-iron beam, three of which traverse the top of the stove resting on wall plates. Four draught chimneys on the corners of the stove control the action of the upper pipe chambers, while the usual gas valve regulates the flow of gas to the combustion chamber. The following advantages are claimed for this stove: perfect control of both gas and pipe heating chambers, greater durability of the heating pipe with no warping or toppling over, so destructive to the standing pipe stove, the great facility of repair, and economic first cost of construction. The joints are all planed and placed outside the heating chamber.—*Engineering.*



IMPROVEMENT IN HOT-BLAST STOVES.

ORE FURNACE IMPROVEMENT.

By H. H. EAMES, Oakland, Cal.

RELATES to certain improvements in that class of furnaces for roasting fine or pulverized ore, in which a series of horizontal shelves or partitions are placed at intervals, one above another, inside of an upright stack or shaft, and in which the ore is caused to drop from one shelf or partition to another by arms or sweeps attached to an upright rotating shaft.

When a simple iron shaft is used for this purpose, the intense heat to which a portion of it is subjected causes it to warp and soon become useless.

It is therefore necessary to devise some means for keeping the shaft cool, when the furnace is in operation, in order to work the furnace successfully.

Let A represent the shell or inside wall of a stack or shaft furnace, inside of which two or more shelves or partitions, B B, are placed at intervals apart, one above another, so that the ore can be dropped from one shelf to the other by arms or sweeps C C, which are secured to an upright rotary shaft, D. The lower end of this shaft D terminates inside of the furnace, while its upper end extends above its top, as shown. In order to protect the shaft D and its arms C C, from the corroding action of the sulphurous fumes generated in the furnace, I coat or cover them with enamel or other material or substance, which will resist their action. For the purpose of keeping this rotary shaft cool, I lead a pipe E, from the pump F, or other source of water-supply, and pass it down inside of the hollow shaft until its extremity is near the closed lower end of the shaft. This pipe E must be smaller than the hole in the shaft, so that an annular space will be left around it, through which the water can pass upward and be discharged from the upper end of the shaft into a dish *g*, which surrounds its upper end, and from which it is conducted away through a waste-pipe *h*. In the present instance I have represented a dish attached to the upper end of the shaft, which overflows into the dish *g*, but the upper dish is not necessary, if the shaft passes directly up through the middle of dish *g*.

I thus provide a constant stream of water inside of the shaft E, which will keep it cool, and prevent the unequal expansion arising from the difference in temperature between the lower and upper ends of the shaft.

Fig. 1.

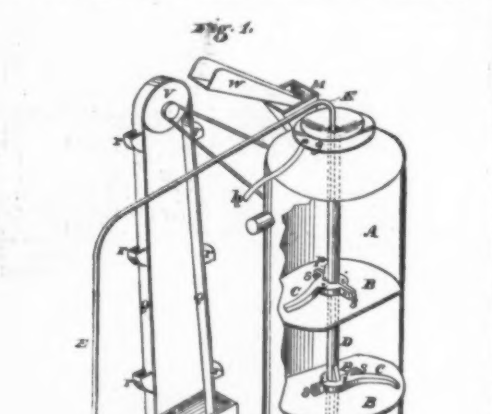


Fig. 2

IMPROVEMENT IN ORE FURNACES.

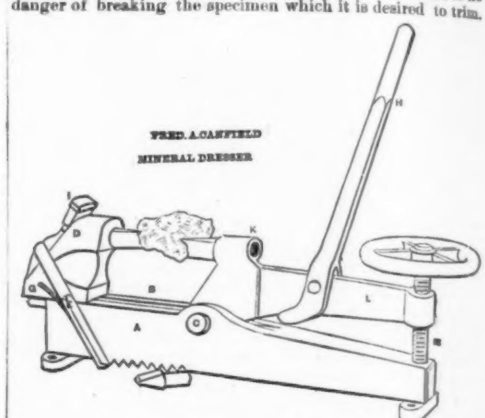
CANFIELD'S MINERAL DRESSER.

IN a paper read before the American Institute of Mining Engineers, Prof. T. Egleston says:

The machine is composed of a cast-iron bed-plate A, which is nearly square at one end, and slightly inclined at the other, and is fitted with projections which are pieces with holes to receive screws for fastening it. The surface B is planed and slotted with a V groove to receive a sliding cast-iron head, D, which is held in the position to which it has been adjusted by means of a wrought-iron clamp E, which fits into a series of notches in the underside of the bed-plate. In the back of he head it fits into a semicircular slot, made in projections on both sides of the head. It is kept in position by a brass spring G, and when once adjusted is held firmly in position by means of the steel wedge I, which is driven in so as to force the clamp up against the bottom of the bed-plate. The head D is provided with a slightly tapering hole to receive the tempered steel chisels, of whatever shapes, that are to be used in dressing. Opposite the sliding head there is another head of wrought iron, which has a long arm L attached to it. This head rotates on a pivot C, which runs through the bed-plate, and is fastened with a nut on the opposite side. The end of the long arm is enlarged to receive the steel screw M, which raises the arm or lowers it, according to circumstances. This head also has a conical hole for the reception of various kinds of chisels which are to be used. The end of the chisel in the head K is almost directly over the axis of rotation C, so that any short movement of the screw M will cause it to move in a nearly horizontal direction. To use the instrument, the screw is run up so that the long arm of the head K almost touches the bed-plate; the wedge is taken out, the hand is pressed upon the lower part of the clamp E, so as to free the head D. The specimen is then placed between the two chisels, and the head D shoved up against the specimen to the exact point where it is intended to cut. When the chisels are in contact with the stone, the wedge I is replaced and driven up; the screw M is then slowly turned by means of the wheel. A few turns of the screw will cut off the hardest rock very nearly square. The length of the cutting surfaces of the chisels may be made to suit the work to be done; they are usually about an inch and a quarter long.

The action of the pressure is such that when the separation of the rock takes place there is very little jar. The rock is simply cut at the point where the chisel acts, and almost the whole force of the machine acts betwen the two chisels, so that there is no danger of the specimen becoming deteriorated from the jar. I have, in this way, frequently cut the hardest rocks, both sides of which were covered with delicate crystals, without any damage to the crystals, in fact, without disturbing any of them in their position.

The motion of the screw is so slow that the action of the chisels is like that of a very powerful shears. The chisels can be turned at any angle which may be necessary to suit the form of the specimen, or may be made in any shape to suit the different kinds of work it is required to do. For dressing soft rocks and slates, where a quick sharp action is required, a lever O is adapted to the wrought-iron arm L, which may be easily removed when it is not required; to use it, the screw is turned up so as to allow the arm to drop upon the bed-plate. The heads are then adjusted as before, and while the specimen is held in the hand, the chisels are made to act by a series of short quick movements of the lever. This adjustment is of special use for trimming shales or soft rocks containing fossils, and is so effective that there is no danger of breaking the specimen which it is desired to trim.



MINERAL DRESSING INSTRUMENT.

Every collector of minerals will appreciate the value of such a machine, for the most skilful adept in the use of hammer and chisels is often compelled to keep a cumbersome specimen in his cabinet, or run the risk, when the mineral has an easy cleavage or adheres slightly to the rock, of destroying it, for the stroke of the hammer, no matter with how great skill it is directed, will often exert its power, not upon the rock, but upon the crystal, which it will detach or cleave, after which there is no repair. The power which is exerted is very great, more than sufficient to trim into shape any specimen which would be required in a mineralogical, geological, or palæontological cabinet.

Since the introduction of this machine into the mineralogical laboratory of the School of Mines, we have had very little use for hammers and chisels, and the attempt to dress an unwieldy specimen has not once resulted in disappointment.

BEVELLING CIRCULAR PLATES.

By PEDDER & ABEL, Beaver Falls, Pa.

THE circular blank to be bevelled is heated and placed between the disks *c*, *d*, on the centre-pin *d'*, and the lever *f* operated to force the clamping-disk *d* down on the blank. While the blank is thus held, the bevelling-dies *g*, *h* are caused to act vertically upon the edge of the blank projecting beyond the disks, the disks and blank being revolved during the bevelling process, so that the entire projecting edge is acted upon by the dies alike, thus securing a uniform and regular bevel.

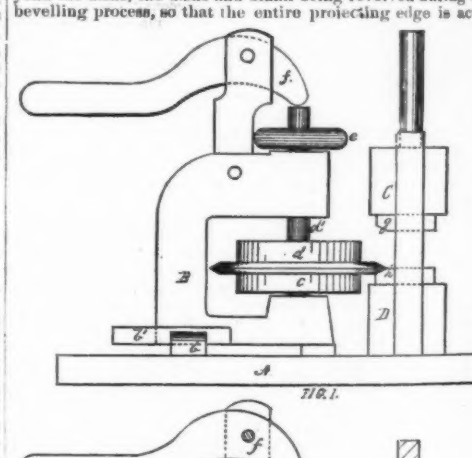


FIG. 1.

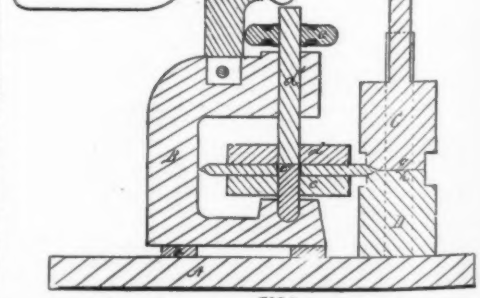


FIG. 2.

MACHINE FOR BEVELLING CIRCULAR PLATES.

The revolving motion of disks and blank may be caused by the rise and fall of the dies, or the dies may be caused to travel around the fixed blank if preferred.

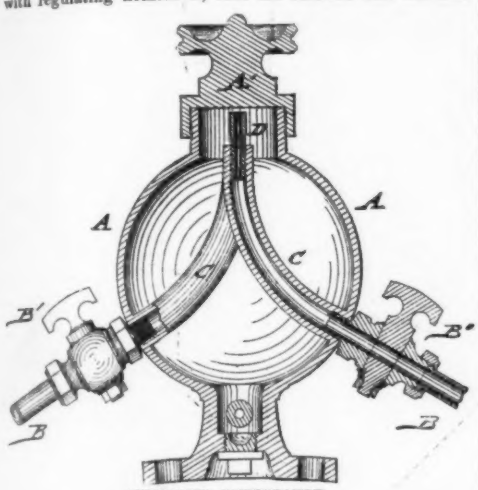
The essential feature of the machinery employed must, however, be such that the blank is held with a fixed centre, and the bevelling-dies act vertically (or in line parallel to the axis of the blank) and continuously on the entire periphery of the blank.

The advantage derived from the invention is the rapidity and facility with which a circular blank may be bevelled without distorting or injuring the blank.

IMPROVEMENT IN LUBRICATORS.

By J. W. Reed, Kalamazoo, Mich.

The cup A is connected by steam-pipes B at opposite sides of the cup, with the steam-chests of the cylinder. Each pipe B has a stop-cock B' at the outside of the cup, by which the steam connection may be shut off in case one side of the engine breaks down. The feed-pipes C at the inside of the cup are made in one casting with the body of the cup, and extended from the exit-points, at opposite sides, in an upward curve, to some distance from the cup A'. The upper ends of the feed pipes are placed sidewise to each other, and provided with regulating nozzles D, that are screwed into the feed-



IMPROVED LUBRICATOR.

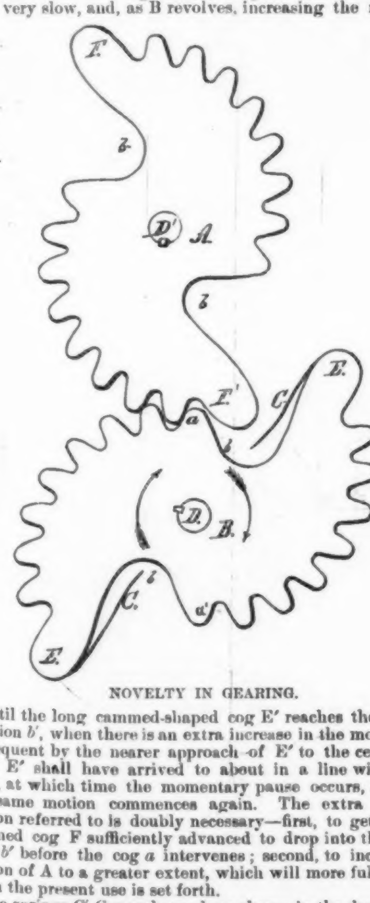
pipes so as to be set conveniently a small distance (about one eighth of an inch, more or less) from the cup.

The casting of feed-pipes and cup in one piece makes the cup cheaper, and without joints. The connecting-pipes B are screwed from the outside into the feed-pipes C. The steam passes up the pipes from the steam-cylinder, and condenses gradually in the cup, which, by the double condensation of the pipes, forces the oil up the nozzles and down the pipes as long as the engine is running. When the steam is shut off, the supply of oil is interrupted, being regularly supplied when the steam is let on again.

IMPROVEMENT IN GEARING.

By A. B. Smith, Denver, Col.

The object is to convert a regular rotary motion into an irregular rotary motion by the means of what may be termed double-cammed gears A and B, secured on shafts D' D, B being the driving-shaft and regular motion, and A being the driven shaft and irregular motion which is produced by the increasing diameter of the driver B, and the decreasing diameter of the driven A, making an increased motion of A from slow to fast, while the driver B turns half way over, and then at once drops from fast motion to a momentary pause, and then repeats the same motion again from slow to fast, and so keeps repeating. When the cog *a* comes in contact with the long cammed-shaped cog F', the motion of A is very slow, and, as B revolves, increasing the motion of

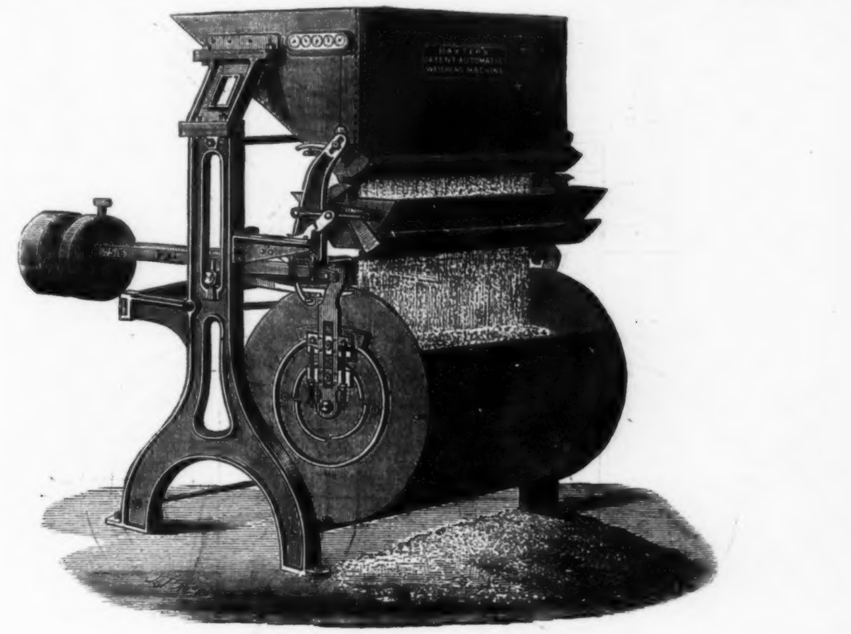


NOVELTY IN GEARING.

A until the long cammed-shaped cog E' reaches the deep depression *b'*, when there is an extra increase in the motion of A, consequent by the nearer approach of E' to the centre of A, until E' shall have arrived to about in a line with shafts D D', at which time the momentary pause occurs, and then the same motion commences again. The extra increased motion referred to is doubly necessary—first, to get the long cammed cog F sufficiently advanced to drop into the depression *b'* before the cog *a* intervenes; second, to increase the motion of A to a greater extent, which will more fully appear when the present use is set forth.

The springs C' C may be made as shown in the drawings, or of rubber inserted in a cavity in the edge of the wheel, and are used to prevent any blacklash in the cogs while changing from a fast to a slow motion.

The object to which I apply the motion at present is to reciprocate the tables used in stamp-mills for reducing and concentrating ores, which tables of themselves are quite heavy, and, when loaded with pulverized quartz, are still more so, and have to be run at a given speed to produce the desired effect on the pulverized quartz, as the tables strike a solid resistance at each end of the stroke, and hence, when started in an opposite direction, it must be done by commencing to move slowly, so as to not create any undue strain or jar on the machinery, and more especially so as not to slide the pulverized quartz on the table, and at the completion of the stroke it must be quick to give the shock. I get the above-required motion by having a crank attached to the shaft D', and, by a pitman, transmit the motion to the table. Right here comes in the point referred to heretofore about extra increased motion. As the crank nears its so-called


AUTOMATIC GRAIN-WEIGHING MACHINE.

dead-centres, there is little or no lateral motion—hence the second reason heretofore named.

SELF-ACTING LUBRICATOR.

The accompanying engraving illustrates a neat lubricator just brought out by Mr. Pickering, Stockton-on-Tees, Eng.

A is the vessel containing oil, tallow, or other lubricant; B is a screw plug for supplying the same; C is a spindle working loosely in the bottom, and having a valve, D, on it, which will rise and fall to the faces when steam is admitted and exhausted to and from the cylinder; the steam does not pass the valve into the vessel, and consequently there is no condensation. It can be filled while the engine is working. At each motion of the valve a small quantity of lubricant passes into the cylinder—that is to say, during the time the valve is off its seat, short as that interval may be. The arrangement is simple and ingenious; but it is obviously not suitable for inferior lubricants, which would clog the valve. This is really not a defect but an advantage, as much harm is done to steam cylinders and valve faces by the use of so-called "cheap" grease and oil.

AUTOMATIC GRAIN-WEIGHING MACHINE.

Among the exhibits at the recent Royal Agricultural Fair was that of W. H. Baxter, of London, consisting of his automatic self-registering grain-weighing machine. It is made in various sizes. The most usual form is capable of measuring six bushels per minute, without labor, power, or attention of any kind, and at the same time registering the quantity on the dial. No adjustment is requisite, except when, after measuring one description of grain, it is necessary to employ the machine to measure another sort; the counterpoise has then to be shifted to the required point on the beam, as denoted by the marks thereon. The accuracy of the machine is undoubted, as it can not discharge its load until the compartment is more than full, when the drum turns over, and the "strike" takes off the superfluous quantity, and retains it until the next compartment comes up to receive it. By a peculiar arrangement, the momentum of the falling grain is always the same, so that whatever may be the quantity in the hopper, or above it, the compartment is invariably filled in precisely the same manner. This ensures an accuracy which can never be attained by hand. The automatic and self-registering weighing machine may thus be described, and its construction will then be readily understood: The grain may be fed into the hopper by hand or by elevators, or in any other convenient manner; but in many cases the machine can be placed under a shoot or spout (in connection with the bulk to be weighed), so that a continuous feed is secured without labor. Having determined the quantity that shall be registered at each tip of the cylinder, and adjusted the weight accordingly, the operation of weighing may commence. The material being led into the hopper, descends into the compartment beneath, until the quantity, nearly equivalent to the weight indicated on the steelyard has fallen; the diminishing valve then reduces the stream of falling material to such an extent that its *momentum* is not sufficient to influence the beam; the actual weighing here commences, and as soon as a correct balance is attained the cut-off instantly stops the supply *to the cylinder*; at the same moment the cylinder is released; it then turns and discharges its load. Being lightened, it rises, presenting the next compartment to be filled, opens the cut-off (letting out the corn collected therein), and the diminishing valve actuates the index, and the operation is continued so long as there is any thing in the hopper. This machine exactly imitates the action of a man who shovels in large quantities until he has *nearly* obtained the correct weight, and then sprinkles a little with his hand to obtain an exact balance. Its advantages are more especially apparent in weighing corn in and out of ships, granaries, or sacks. With suitable tackle it will save at least one man in each discharge or removal of bulk, and at the same time preserve a correct register of the quantity weighed. The indicator and counterpoise may be so protected that they can not be tampered with, and thus cheating or error prevented. In connection with properly arranged elevators, travelling bands or screws, the cargoes of ships may be raised, *weighed*, and stored, without the intervention of labor at any point. In filling sacks from under the bulk, one man will be saved, and the operation carried on at twice the speed, as while one sack—hung by slings—is filling, the preceding one may be tied; at the same time the foreman can, by a glance at the indicator, observe the quantity withdrawn and the progress of the work.

NEW MACHINE FOR DRYING GRAIN.

By A. W. Roper, St. Louis, Mo.

A is the frame of the drier, supporting the drying-pans B B', through the centre of which passes the driving-shaft C, carrying the rakes E, the teeth of which are so inclined as to carry the grain inward and outward on alternate pans. The grain is carried inward on one pan and discharged through a central opening *b*, and is carried outward in the next pan of the series and discharged over the edge into the pan beneath.

H is a coil of steam-pipe, one of such coils being provided for each of the pans.

FIG. 1.

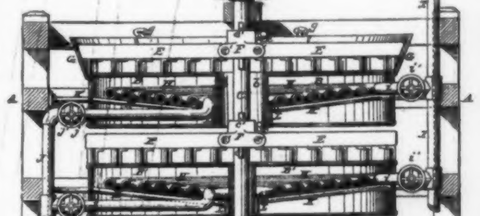
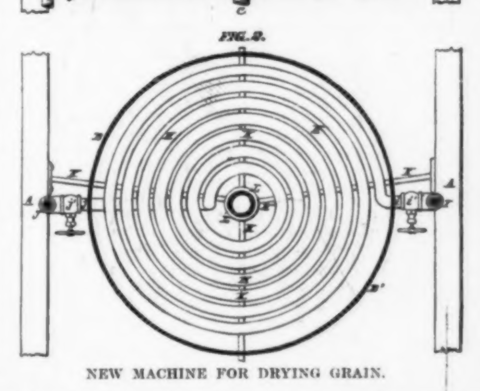


FIG. 2.



NEW MACHINE FOR DRYING GRAIN.

The grain or other material is supplied to the upper pan near its periphery, and carried inward to the central discharge, where it drops on to the pan B' beneath, on which it is carried outward and drops from the periphery of the pan on to the flaring edge G, and top of the pan beneath.

ATLANTIC STEAMING.

Two or three years since, there were about 150 steamers, worth more than $90,000,000, employed between Europe and the United States, all of them, except about half a dozen, being owned by Europeans. Since the summer of 1874, a great change has, however, taken place in the business of the companies owning these ships. At present between 40 and 50 of the ocean steamers which once plied regularly between Europe and the United States are moored at their owners' wharves in England and Germany, with absolutely nothing to do. These are not old worn-out vessels, but sound first-class steamers. In other words, about $25,000,000 of good property, once employed with profitable results, is now idle and not yielding a cent of revenue.

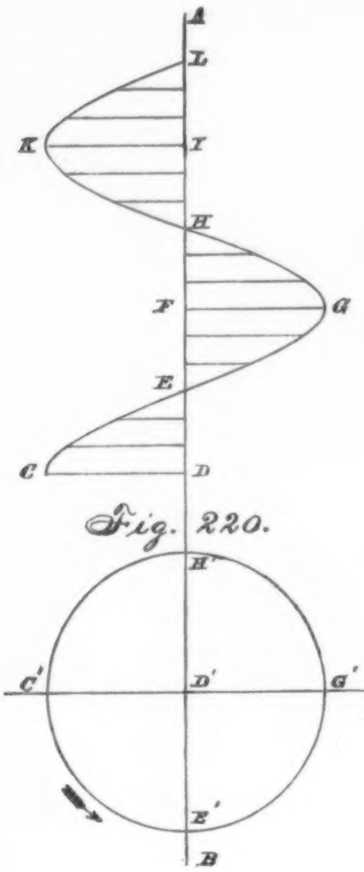


Fig. 220.

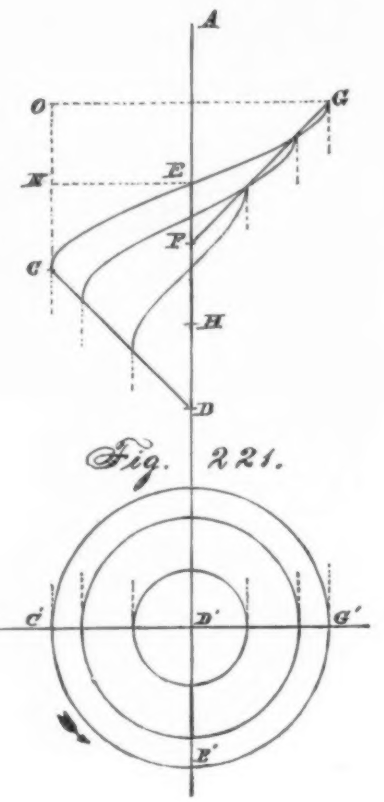


Fig. 221.

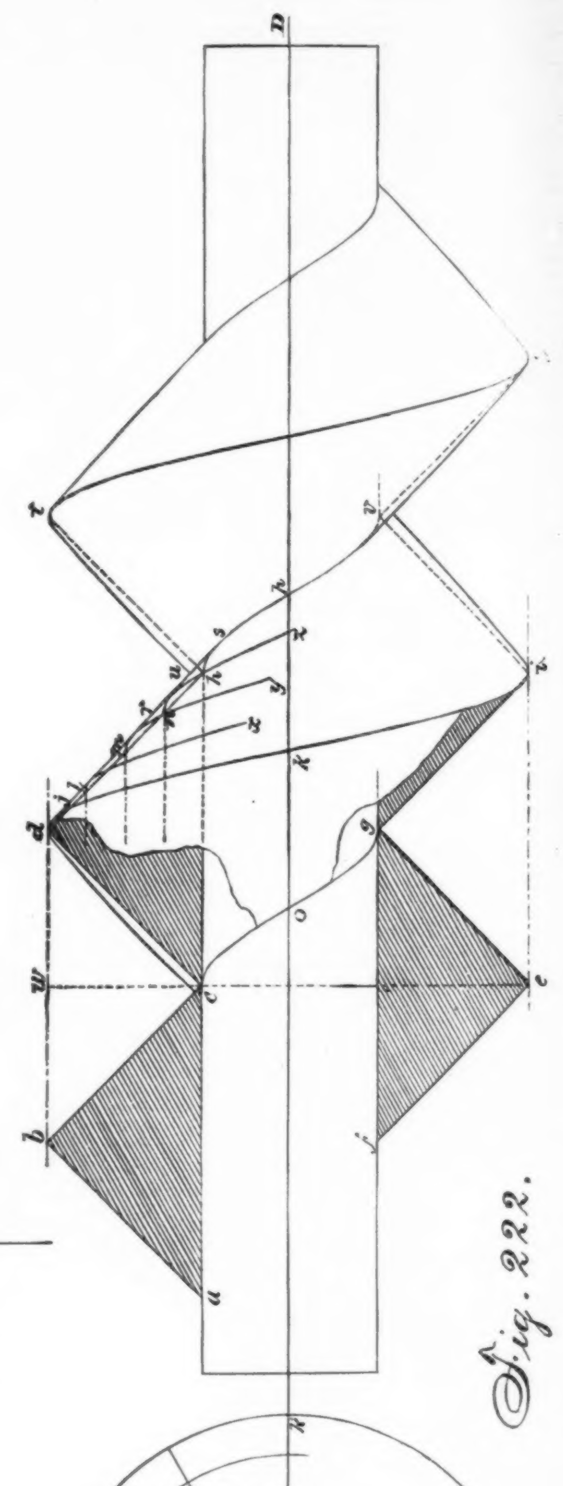


Fig. 222.

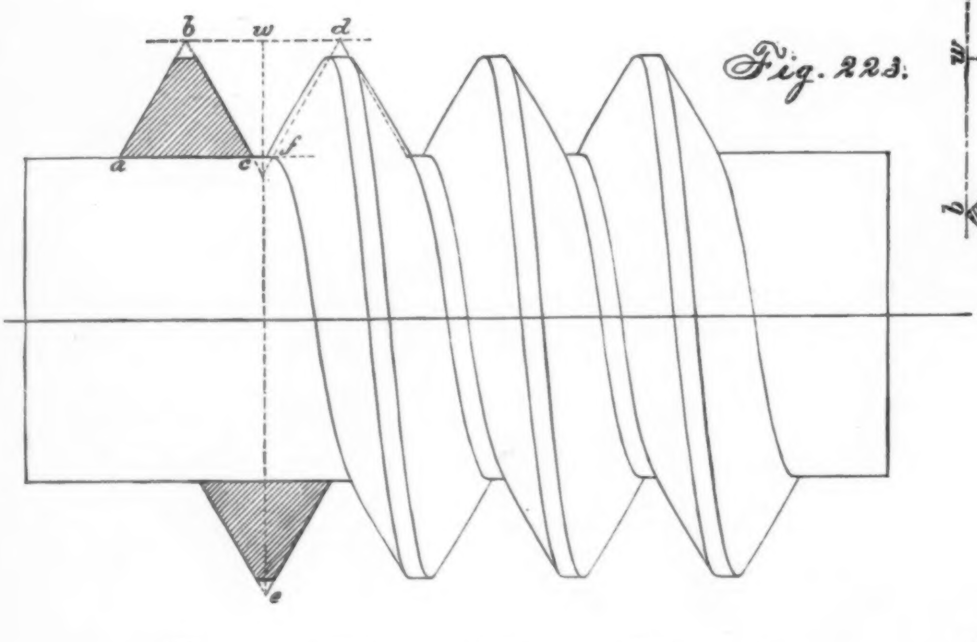


Fig. 223.

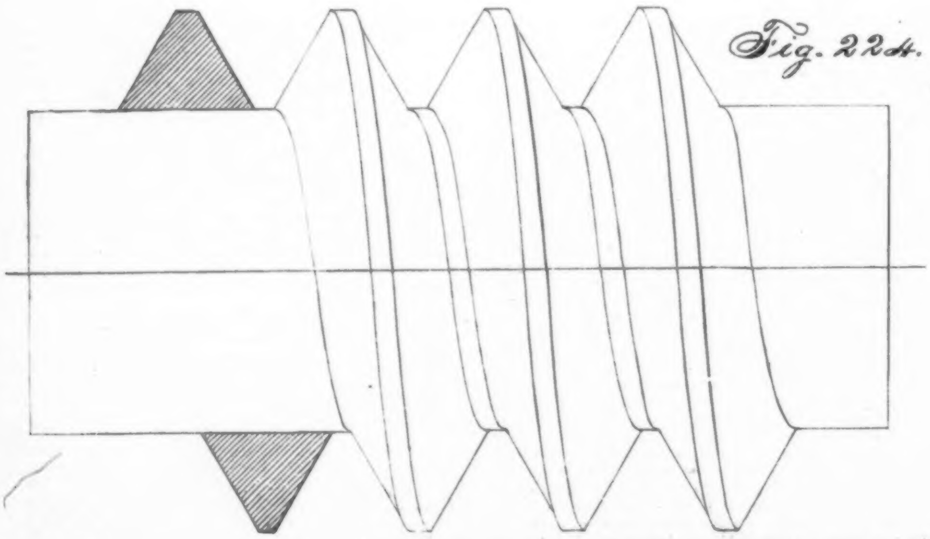


Fig. 224.

LESSONS IN MECHANICAL DRAWING.—No. 2

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MacCord.

No. XXV.

In explaining the mode of drawing the screw, we made use of an illustration intended to give an idea of the nature of the twisted surface of the thread, by supposing it to be formed by winding a flexible bar of metal upon a cylindrical rod or core. It was remarked at the time, however, that the manner of forming this surface might be explained in a different manner, which in one sense might be regarded as more simple. This is shown in Fig. 220, in which A B is a vertical line, which may be considered as the axis of the screw. C D is a horizontal line intersecting A B; now if we suppose C D to turn around A B, and at the same time to advance along it, the double motion will generate the peculiar surface shown in the figure. The rates of rotation and of advance are supposed to be both uniform, and under these conditions the surface will be identical with that of the square-threaded screw; which will be clear if we reflect that every point in the line C D describes a helix, the line itself being always horizontal. We have given a top view, which may aid the student in following the motion of the line: thus, C D corresponds to C' D', and the direction of the rotation being shown by the arrow, when the line has made a quarter turn it will be seen in the top view as D' E', and appear in the side as merely the point E: after a half turn it will have in the top view the position D' G', in the front view the position F G, and so on. Thus the point C describes the helix C E G, of which D F is half the pitch.

This surface is called the *helicoid*, and is of some interest in its practical applications, since not only the threads of common screws, but the blades of many if not most screw propellers, are of this nature. The particular one here shown is distinctively called the *right* helicoid, because the line C D, which generates it, is at right angles to the axis. But it needs only a moment's thought to show, that if this line were inclined to the axis at any other angle, a kindred surface would be generated by a similar compound motion of the line, around and along the axis. Thus in Fig. 221, C D is inclined to A B, and turning round it, always making the same angle with it, and at the same time advancing, we see that after half a turn it will have the position G F, the vertical distance C O being equal to D F. At the quarter turn, the line C D will have the position shown in the top view as D' E', and in the side view as E H, the distance C N being equal to D H, the half of D F. It will easily be seen that every point in the line C D in this case also describes a helix, of which D F is half the pitch, and a few of these helices are shown in the figure. But while in Fig. 220 the horizontal lines, or right-line elements of the surface, do not confuse each other, but on the contrary rather aid in giving an idea of the surface, it is obvious that in Fig. 221 the attempt to show the successive positions of C D would give no assistance, but simply make the diagram unintelligible.

The surface shown in the latter figure, or more correctly the surface generated in the manner there illustrated, is that met with in the V-threaded screw. But we think that a clear idea of this surface may be formed more readily by the use of a concrete illustration similar to that employed in explaining the formation of the square-threaded screw; and this is shown in Fig. 222. C D is the axis of a cylindrical core, upon which we may suppose to be wound a bar of flexible metal, of triangular section, as shown at $a b c$. This bar is supposed to be wound so that the adjacent coils, as $a b e$, $c d h$, touch each other; under which circumstances, each point in the lines $a b$, $b c$, will describe a helix whose pitch is $b d$, which is equal to $a c$ the base of the triangular section.

Now, if we regard the surface generated by the line $d h$, we see, first, that the helix $d k i$ is visible from d to i, at which points it is tangent to the cylinder on the surface of which it lies, whose outlines are $b d$, $e i$. The line $d h$ may be supposed to lie in the plane of the paper, and we see, next, that the helix comes up between $d h$ and the observer, and apparently crosses it; so that, as the screw thread we know is bounded by an unbroken surface, that part of $d h$ between d and j, the point of intersection with the projection of the helix, is concealed. If we take any other point, as l, on $d h$, it also will trace a helix of the same pitch, but lying on a smaller cylinder; a part of this, $l x$, is shown, and we find that another part of $d h$ is concealed. So with m and n, which describe the helices partially shown in $m y$, $n z$; and as we may draw any number of such curves, each concealing a portion of $d h$, we find at last that d is the only point of that line which remains visible.

It will be observed, however, that the portion $d j$ is concealed by the surface of the other side of the thread, that is, by the helicoid generated by the line $d e$; but from j to h the line is hidden by the surface generated by itself. In the figure, we have taken only the three intermediate points, l, m, n, for illustration; by using a greater number, and drawing the helices described by them, or at least the first parts of those curves, we should find the spaces between the crests of those here shown to be gradually filled up, and the apparent contour, or visible outline, of the twisted surface to be more clearly defined; and it will evidently be the *envelope*, or curve tangent to all these helices, $d r s$.

In a manner precisely similar, we may find the apparent contour of the surface described by $d e$, as it recedes; but one construction is sufficient, as $d e$ is symmetrical with $d h$, and the curve will when found therefore be precisely like $d r s$, only reversed, that is, drawn left-handed instead of right-handed; thus also with $t h$ and the visible outline of the surface it generates, which will disappear behind $d r s$; being tangent, if prolonged, to the continuation of the helix $p s k$. And the process of drawing the surface below the axis is exactly the same, so that in fact we have only one construction of the outlines to make, no matter how long the screw is.

Thus we see that although the section of the thread, $a b c$, is bounded by right lines, the apparent outline of the thread is curved. We have purposely selected a form and proportion of thread, which it is hardly likely would be met with in practice, unless possibly it might be if the screw were made of wood, with the object of making the peculiarities of its form and construction as conspicuous as possible. And we wish it to be understood, that it is not by any means necessary, under all circumstances, to go to the trouble of drawing the screw with all this minuteness of detail. But when it is necessary to draw a large one, it is desirable that it should be drawn correctly; and, moreover, there are practical cases in which it is important to know exactly what the apparent contour is like.

In the case here illustrated, since the adjacent coils of our flexible triangular bar touch each other, it is clear that if we bisect $b d$ in w, and draw through w a line perpendicular to the axis, this line will pass through e, the *root* of the thread, and also through e, the point or crest of the thread on the opposite side of the axis, so that $w e$ will also bisect $f g$. The root and the point are then, in the complete screw, in the forms respectively of a sharp edge and an equally sharp groove; the nut being, of course, such as to fit exactly into the groove. Now in the use of metallic screws and nuts, as for example in bolts for holding together the different parts of which a machine is made, these sharp edges are found objectionable. The section of a screw of good proportion, though much coarser than an ordinary bolt, is shown in Fig. 223, at the left. It will be noticed that the upper angle, or edge, b, is cut off, leaving the top of the thread cylindrical; also that the adjacent coils do not touch each other, so that a space, $c f$, is left cylindrical at the root of the thread too.

Under these circumstances the appearance of the screw as a whole is considerably modified, as the figure shows. But the process of drawing it is not changed in any essential particular, and if the student has practically mastered the explanation of Fig. 222, he will need no further aid.

In the last figure, the section of the thread, before the top is cut off, is an equilateral triangle; and it will be observed that the curvature of the outline of the complete thread is not so great as in the preceding case. Still, if the drawing be large, it ought not to be neglected altogether, although it very frequently is. The effect is shown in Fig. 224.

The construction of the section of a pyramid by a plane, as explained in connection with Fig. 207, will perhaps have suggested to some of our readers the mode of drawing the section of a cone by a similarly inclined plane. But the latter operation involves one or two points which were not illustrated in the figure alluded to, and as it presents a problem of some interest and importance, we give its construction in Fig. 225.

C D is the axis of the cone, of which the side view is $a v b$; L L is the plane, seen edgewise in that view, which cuts the outlines, $a v$, $b v$, in the points e and d, which in the top view are seen at e', d'. If we draw on the cone the line $v c$, it will appear in the top view as $v' c'$; and it will be cut by the plane L L at the point f, seen in the top view at f', perpendicularly under f. So also, if we draw $v g$, it will be seen in the top view as $v' g'$, be cut by the plane at i, and this point will in the top view be found at i', perpendicularly under i.

So far the operation presents no new features; but $v q$ also is a line on the cone, being in fact precisely where $a v$ or $b v$ would appear, if the cone were turned a quarter round to the right or left. And in the top view this line appears as $v' q'$; it is cut, too, by the plane, at a point seen in the front view as y, but since the perpendicular through y coincides with $v q$, we cannot find the position of y in the top view by the method thus far employed.

Now, if we imagine the cone to be cut across horizontally by a plane through y, it is clear that the section thus made will be a circle, whose radius is $y n$. And if this be so, the point y must be as far in front of the axis as n is to the left of it. We therefore set off $v' p$, equal to $y n$, which gives p the top view of y. This may also be seen in another way, thus: If we turn the cone on its axis, a quarter round, $q v$ will take the position $a v$, as above remarked; and in this revolution, y

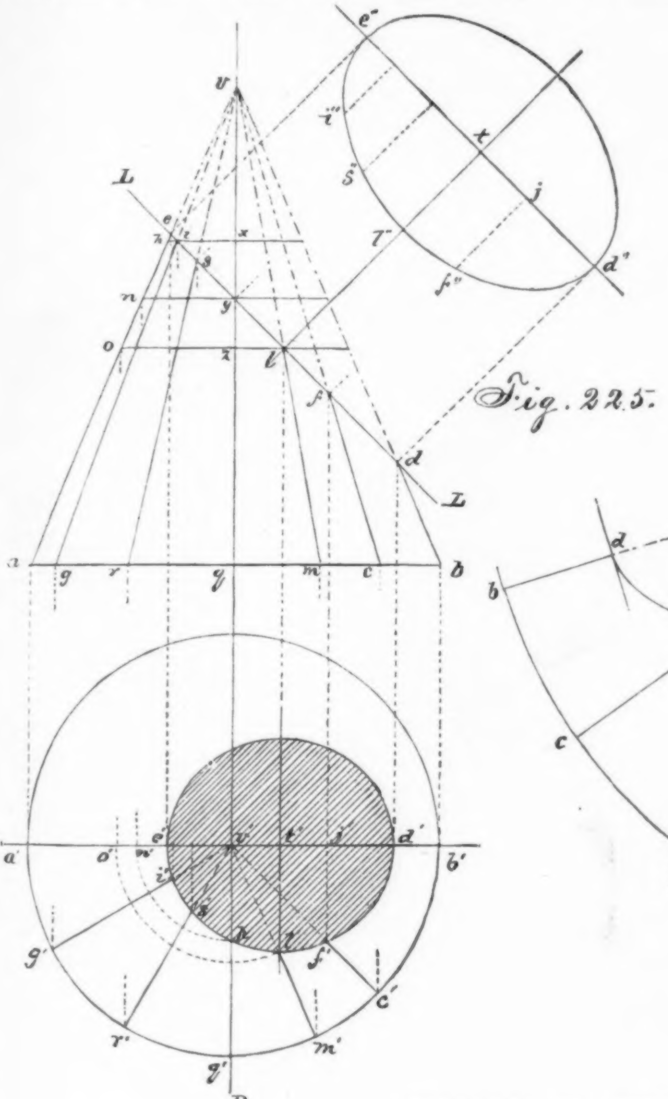


Fig. 225.

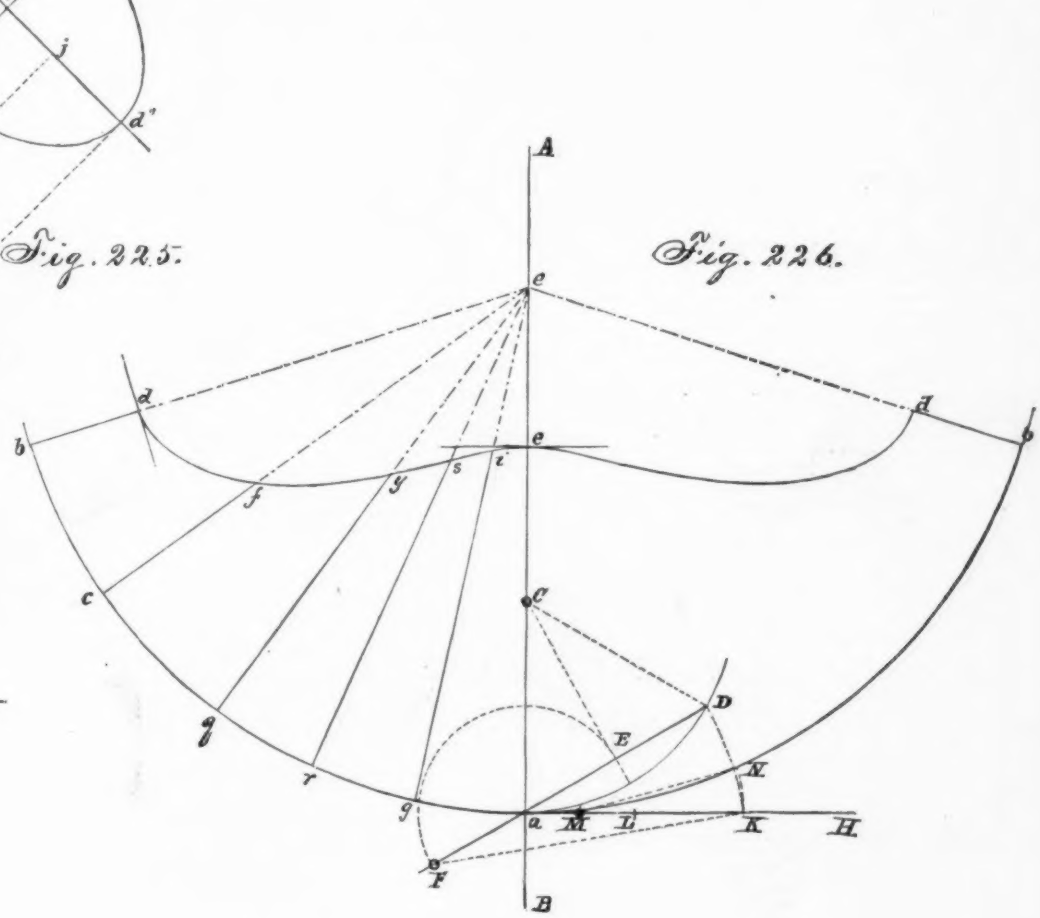


Fig. 226.

LESSONS IN MECHANICAL DRAWING.—No. 25

travels in a horizontal circle, being always in the base of the cone. The point y also travels in a horizontal circle, parallel to the base, and so comes eventually to n, and will then be seen in the top view at n'. Now if we turn it back again, n' will retrace its circle, shown in a dotted line in the top view, and go back to its first position, y in the front view, p in the other. The same method may be applied in any other place as well as in this one: thus we may draw a horizontal plane through i, which will give a circular section of the cone whose radius is $x\,h$, which radius being set off on $v'\,g'$ will give i''. Mathematically, it makes no difference which method is used; but in practice it does, for it is clear that if we draw a line, as $v\,r$, near to $v\,q$ on the cone, it will form in the top view a very acute angle, $r'\,v'\,q'$, with the perpendicular, and the consequence is that the determination of the position of the point in that view will not be very reliable. But in the second method, all the horizontals, $x\,h$, $y\,n$, $z\,o$, make the same angle with $a\,v$, so that the determination of the radius of the circular section is equally definite in all cases; and all the circles in the top view cut the radii which there represent the right line elements of the cone, at right angles: this method is therefore in general to be preferred.

In the case of the cylinder cut by the inclined plane, Fig. 212, it was stated that the section was in fact an ellipse, although in the top view it appeared as a circle. It may now be stated, that the section of the cone here given is also an ellipse, and it will appear as one also in the top view. Knowing this fact, we might construct it as such at once, if we knew the axes. It will easily be seen that the major axis will be $h'\,d'$; and the minor axis may be found thus: Bisect $e\,d$ in l, and draw $v\,l\,m$; project m to m', and draw $v'\,m'$, the top view of $v\,m$, then drop the vertical line through l, cutting $v'\,m'$ in l', and $a'\,b'$ in t'; then $t'\,l'$ is half the minor axis. Or, better, use the second method, drawing the horizontal $l\,o$, which gives $z\,o$ the radius of the circular section, and set off $v'\,l'$ equal to $z\,o$.

In order to find the true size and form of the sloping section of the cone, we must construct a view looking at the plane perpendicularly, as shown in the figure a little to the north-east of the front view. The major axis is $e''\,d''$, equal to $e\,d$, which is clearly the longest right line that can be drawn in the plane of the section; the minor axis is $t\,l''$, equal to $t'\,l'$ in the top view. For evidently $t'\,l'$ is seen in its true length in the top view, because it is a horizontal line; the same is true of $j'\,f'$, $v'\,p'$, and in fact of all lines parallel to these, and we may therefore transfer these measurements at once to the corresponding lines perpendicular to $e''\,d''$ in the view which we are now making, which if carefully done will give us the true ellipse. Or we may construct the latter at once, having the axes, without further reference to the views already drawn.

Now, the cone may also be developed, in a manner similar to that employed in developing the cylinder. None of our readers need be told that the cone will roll on a plane, nor hardly, we suppose, that its vertex will remain stationary if it does, because the slant height, or sloping side, is everywhere of the same length. In other words, every point in the circumference of the base is equally distant from the vertex; consequently this circumference, as the cone rolls on the plane, will become a part of the circumference of another circle whose radius is the slant height, instead of becoming a right line as when the cylinder rolled. The length of the circumference, however, is not changed. What we have to do, then, is first to ascertain this length, and then to find the arc of the circle into which the base circle is developed, which shall be of the same length.

These operations can be readily performed by the aid of the constructions given in Fig. 219, and they are indicated in Fig. 226, which also illustrates the process of drawing the development. On the line A B set off $a\,v$ the slant height of the cone, and describe about v with radius $a\,v$ an indefinite arc. Set off a C equal to the radius of the base, and about C with radius Ca describe another arc, on which set off a D $= 60°$, by describing an arc about a with the same radius Ca. Draw at a the common tangent a H; draw the chord D a, bisect it at E, and prolong it to F, making aF $=$ aE; about F describe the arc D H, cutting aH in K, thus making a K equal to the arc a D. Bisect a K in L, and a L in M; then about M describe the arc K N, which by its intersection with the circle first drawn determines the arc a N, equal to aK, and therefore to a D. Then, since a D is one sixth of the circumference of the base, we set off a N three times on each side of a, on the larger circle, which gives us finally the arc $b\;a\;b$ equal to the whole circumference, and $b\;v\;b$ is the development of the convex surface of the cone.

Now, if we imagine the frustum, or lower part of the cone, left after removing the part cut off by the plane L L, to be made of a thin sheet of metal, and cut along the line $b\,d$, we may lay the line $a\,e$ of Fig. 225 on the paper so as to coincide with $a\,e$ of Fig. 226, and unroll it, when the edges formed by the cut will appear as $b\,d$, $b\,d$, on the development. Bisecting the arc $a\,b$ in q, in the latter figure, and drawing $v\,q$, we have the position assumed by the corresponding line, $v\,q$ of Fig. 225. And the point y will appear on this line at a distance from q equal to the actual distance of q from y in the front view. As before explained, $q\,y$ is foreshortened in that view, but will be seen of its actual length if we turn the cone a quarter round, so that the line shall be parallel to the paper, in which case y goes to n, and q to a, so that $a\,n$ is the true length, which we set off from q to y in the development.

In the same manner we can find the positions of as many lines on the development as we please, and by setting off on them the actual lengths of the corresponding ones of the cone, obtained as just explained from the front view, we determine a series of points through which the curve $d\,f\,y\,e$, etc., is traced; and this will be the development of the upper base of the frustum, or sloping section of the cone.

A LARGE number of cotton-seed oil factories are being erected in Georgia, Alabama, and Mississippi.

ORNAMENTAL SILVER LAMP PENDANT.—DESIGNED BY V. MYSKOVSZKY.—(*From The Workshop.*)

PHOSPHOR-BRONZE, AND ITS USES.

THE *Revue Industrielle* publishes the following account of the properties of phosphor-bronze, and of its value for certain purposes:—

The manufacture of alloys known by the name of "phosphor-bronze," the invention of which is due to the founders of the Val-Benoit nickel manufactory near Liége, is rapidly developing. Many foundries established within the last two or three years are devoted to the successful working of these new products, both in this country and America. The result of analyses and observations hitherto made seems to be that phosphorus exercises a double chemical action over the metals which compose the alloys. While reducing on the whole the oxide of tin contained in the mixture, it at the same time forms with the metals it has thus purified a perfectly homogeneous alloy, the hardness and resistance of which are subject to control. The experiments made in London, Vienna, and Berlin leave no doubt on this point, and establish the superiority of phosphorous alloys over ordinary bronze, copper, coke-iron, charcoal-iron, and steel. Under the influence of strains exceeding the limit of elasticity, or violent shocks, their texture does not become crystalline. They are completely free from metals easily liable to attack, such as zinc. Sea water, or diluted solutions of sulphuric acid, have only a very feeble action upon them, and in all cases much less than on pure copper. One of their most valuable qualities is, that recasting does not occasion the smallest loss in tin. Moreover, their degree of liquidity, which may be compared to that of mercury, renders it possible to obtain them without blisters, and to have perfect mouldings. Their degree of fusibility is nearly the same as that of ordinary cannon bronze.

Their application to military art has led to very minute researches. Various European governments have had experiments made which have all established the superiority of phosphorous over ordinary bronze. The following are the chief purposes to which phosphor-bronze is applied:

Toothed Wheels and Transmissions.—These have been often made of phosphor-bronze, especially in cases where certain parts are exposed to sudden and violent shocks. Many of these toothed wheels weigh about a ton and a half. It has been proved that they do not break, and numerous observations show that the teeth of the wheels are twice as hard as those made of ordinary bronze.

Tuyères.—Phosphor-bronze has been strongly recommended for the manufacture of tuyères. Those made of it are found very superior to the ordinary bronze tuyères, showing neither fissures nor signs of wear by the scoriæ after several years. They are beginning to be used in this country (Belgium), and in France. In Germany they are already extensively used.

Pump Cylinders.—On account of its perfect homogeneity and great solidity, phosphor-bronze is well suited for the making of cylinders for pumps or hydraulic presses. It is employed in the making of fire engines, and has been used for the perforators of the St. Gothard tunnel.

Segments of pistons.—Phosphor-bronze is well adapted for these. Its great elasticity and the little friction it causes render it preferable to steel. In engines with three cylinders it has been used with great advantage. Moreover, phosphor-bronze is the only alloy which has been found to possess sufficient resistance for making connecting-rod bearings in engines working at very high pressure.

Parts of machines for powder mills.—An official publication of the English Government states: "There is an alloy called phosphor-bronze, which may be employed with advantage in powder mills. Its resistance is almost equal to that of iron, and when struck it does not give out sparks. It may therefore be safely employed in the making of locks, and the iron-work of doors, windows, etc."

Heavy shafts and screws for vessels.—The tenacity and great resistance of phosphor-bronze render it very suitable for the construction of propelling screw shafts. It has lately been used for making piston rods and bolts of armor plates.

Cables.—As phosphor-bronze does not acquire crystalline texture under the influence of continued or oft-repeated shocks, and is little liable to attack from caustic or acid water, such as is often met with in mines, it is not surprising that it should have been applied to the making of cables for transmission, mines, telegraphs, etc.

To ascertain the resistance of phosphor-bronze to the chemical action of weak solutions of sulphuric acid, two plates of the same thickness were plunged into a bath of acid 10° Baumé, the one of copper and the other of phosphor-bronze, and both were left there for three months in contact with the air. At the end of that time the copper had lost 4.15 per cent of its weight, and the bronze only 2.30.

Armor plates of ships.—Phosphor-bronze admits of being easily rolled into plates which offer a much greater resistance than the best copper, to the action of the sea water. This has been incontestably proved by experiments at Blankenberghe, near Ostend, which lasted more than six months.

Bearings.—This important use has particularly attracted the attention of the Americans. Phosphor-bronze wears from two to five times better than cannon-bronze of the best quality, heats much less readily, and when hot does not eat away the shaft. Hence it is naturally preferred for bearings. Several large railway companies in America have adopted it exclusively for making bearings for locomotives and trucks, eccentric rings, and for the fittings of boilers. A metal possessing the qualities of phosphor-bronze, and the price of which is about the same as that of cannon-bronze, must supersede the latter before long, says the *Revue*, while in many cases it will compete successfully with iron and steel, since it preserves its texture under the influence of the most violent shocks.

THE WINDINGS OF RIVERS.

PROF. JAMES THOMPSON, at the meeting of the British Association, exhibited a model to illustrate the action of rivers in modifying the forms of their windings. He said that most treatises on hydraulics speak of this action as if water consisted of particles impinging against the outer side of the bend, and so wearing it away. This is objectionable, as water does not impinge but presses against the outer bank. The action is more properly as follows: The stream lines of water flow less rapidly from the centre to the outer, and more rapidly from the centre to the inner, side. In consequence of this and fluid friction there is a flow of water at the surface from the inner to the outer side, and below from the outer to the inner. This causes the earth at the outer side to be transferred along the bottom to the inner bank. He illustrated these remarks by the behavior of threads attached to pins stuck in at different parts of the bend of the model river. The bottom threads inclined towards the inner side, while the upper threads inclined slightly towards the outer. The actual state of matters could also be seen from the mud raised by the flow of the stream in the model.

PRECIPITATION OF ZINC.

By M. G. SULHORST.

SULPHURETTED HYDROGEN partially precipitates zinc from a solution of sulphate of zinc containing bisulphate of potassium, but if the proportion of the latter salt exceeds a certain limit the liquid is no longer rendered turbid. Thus, a solution of 2 grms. sulphate of zinc and 1 grm. bisulphate of potassium gives with sulphuretted hydrogen a precipitate of zinc sulphide containing 19 per cent of the total zinc present in the liquid. If the quantity of bisulphate of potassium is raised to 2 grms. there is no precipitation.—*Zeitschrift für Analytische Chemie.*

MICROSCOPIC NOTES.

PROF. H. L. SMITH's mode of mounting objects is on thin disks of colored wax, and with rings of the same material punched from the sheets prepared for wax-flower making. Dr. Frances Hogan recommends as a staining fluid for membranes, or soft sections, a 1 to 2 per cent solution of perchloride of iron, and a similar strength of solution of pyrogallic acid in water or alcohol.